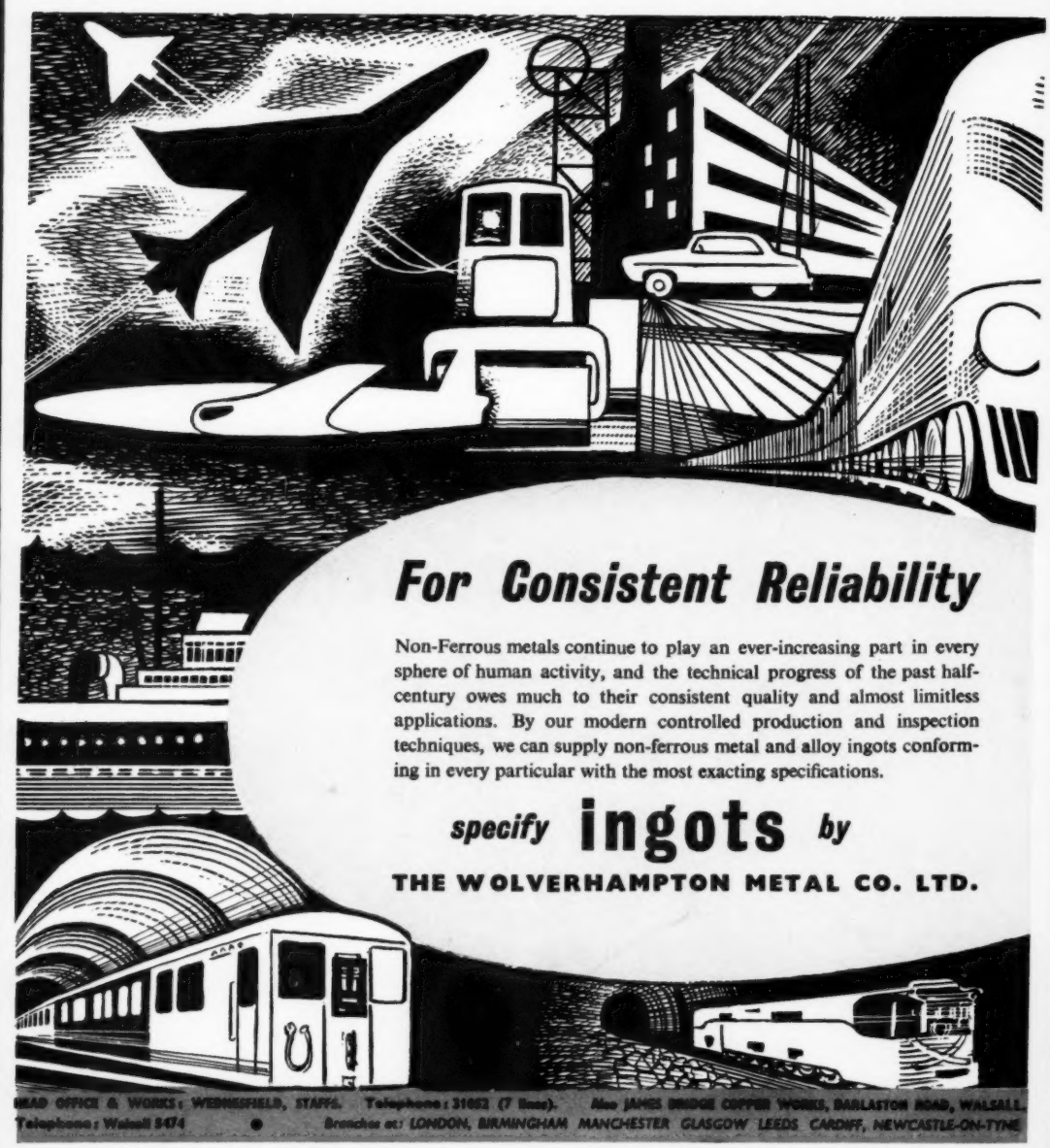

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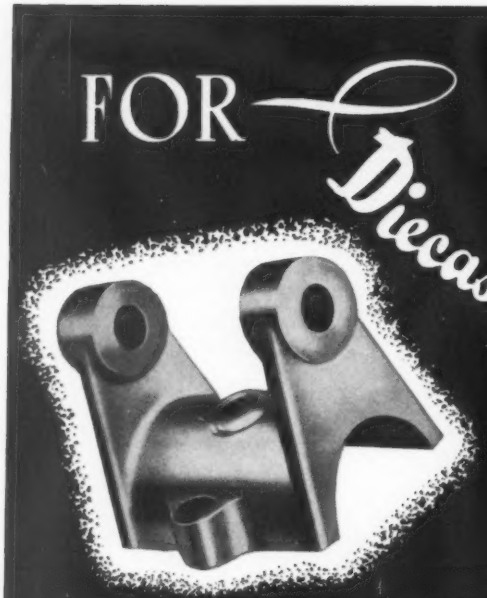

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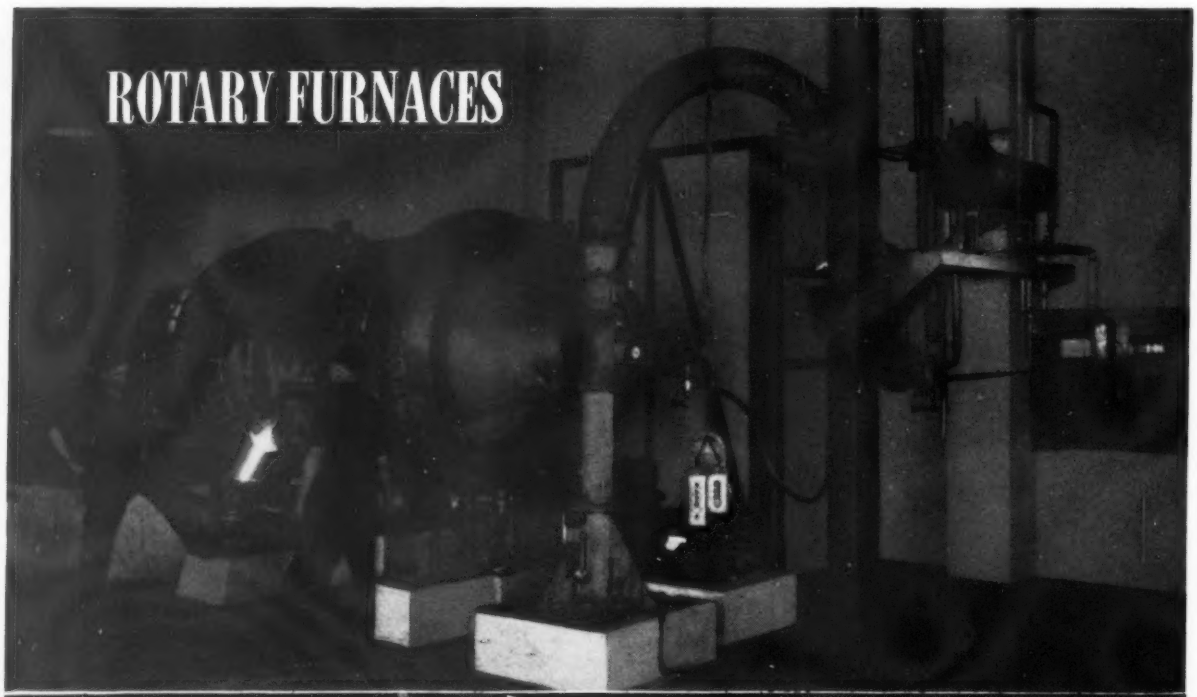

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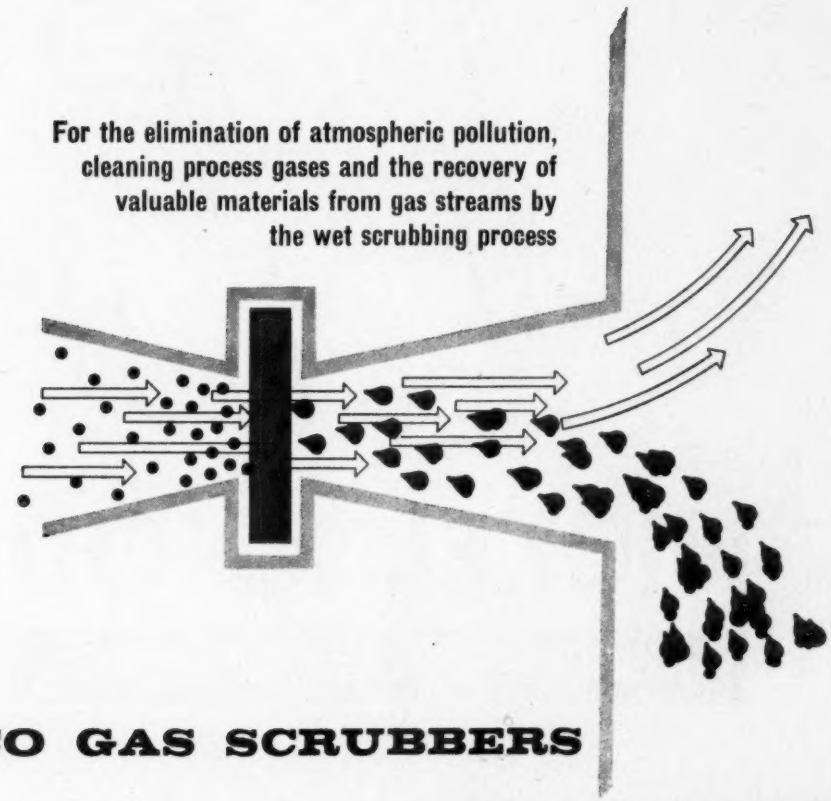

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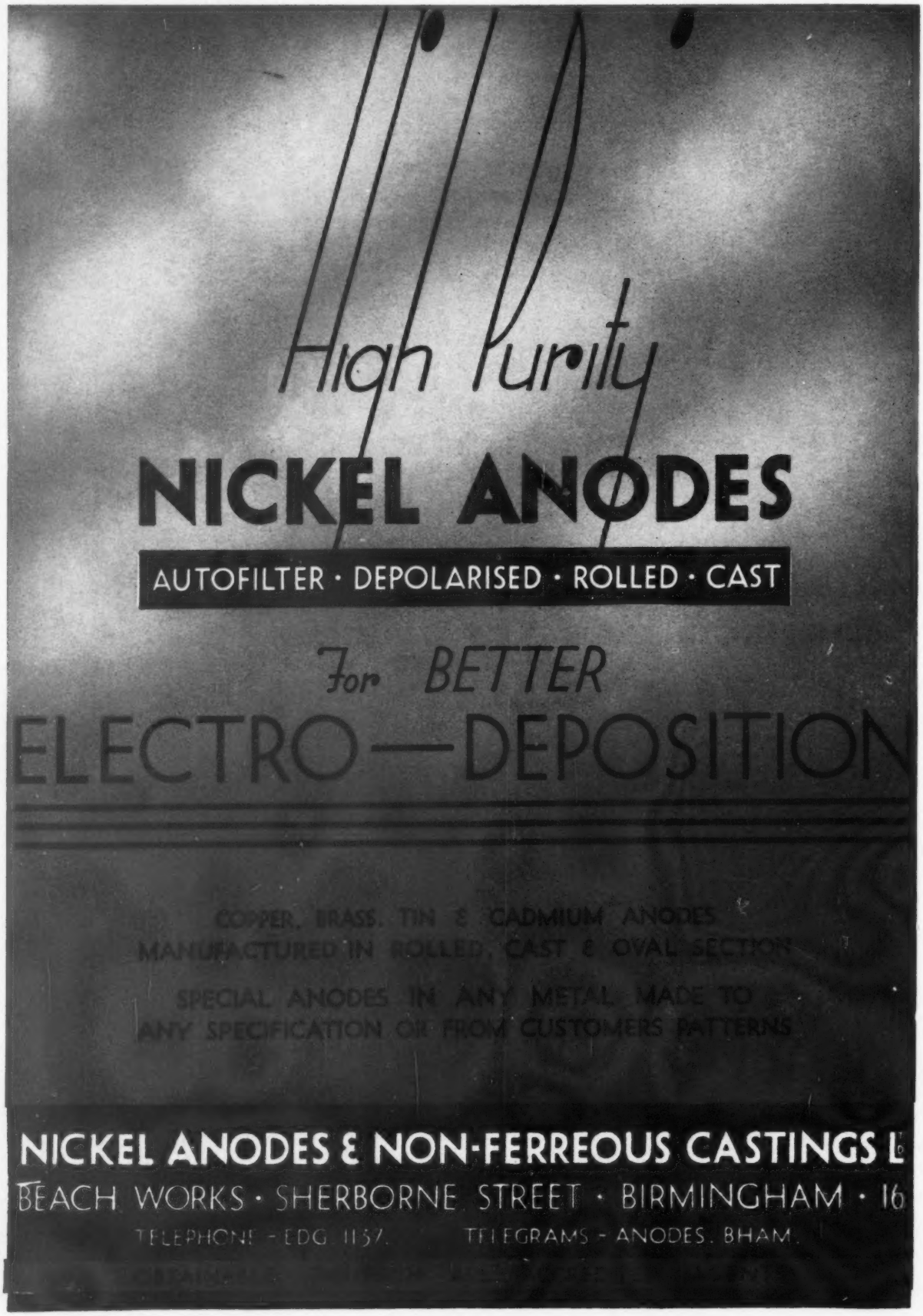
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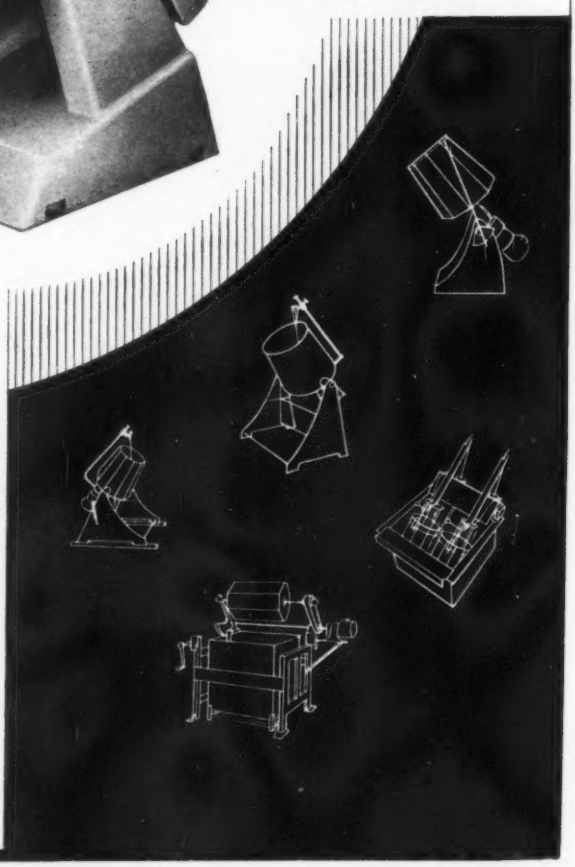

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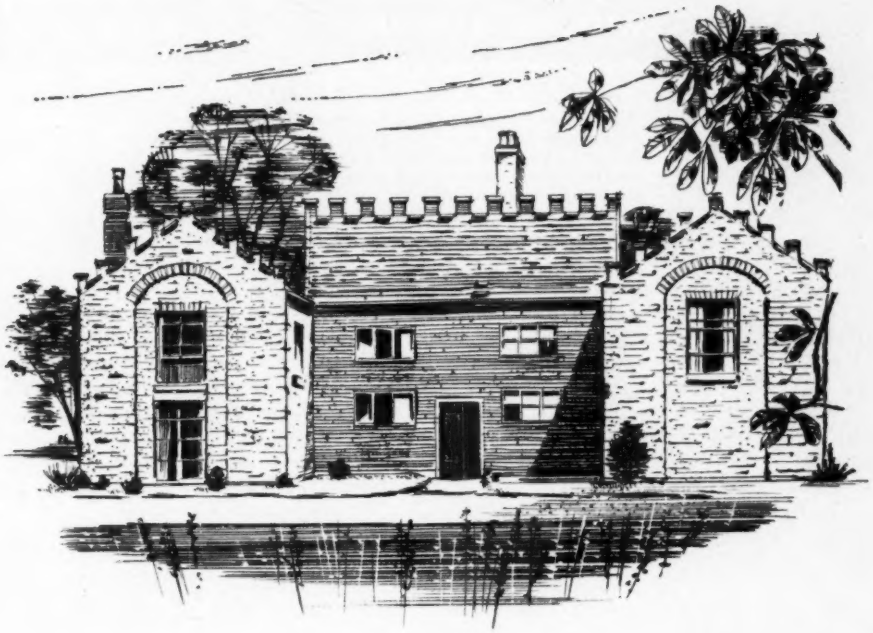

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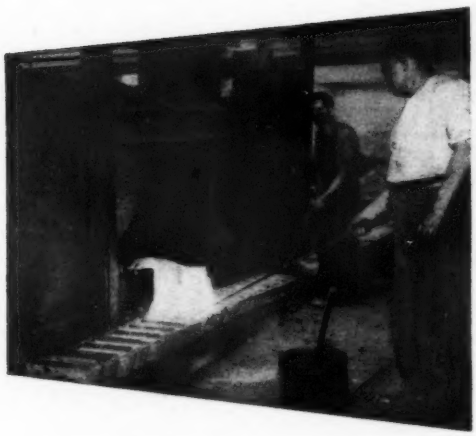

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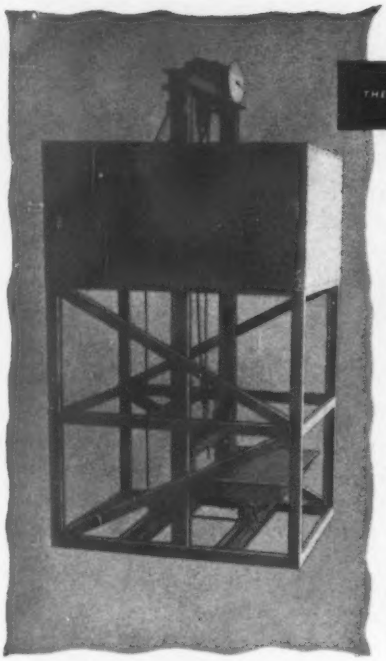

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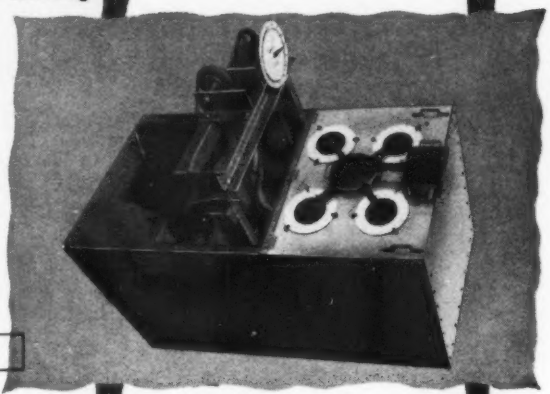

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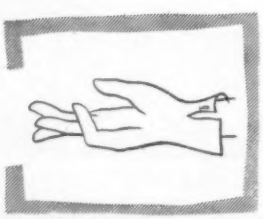

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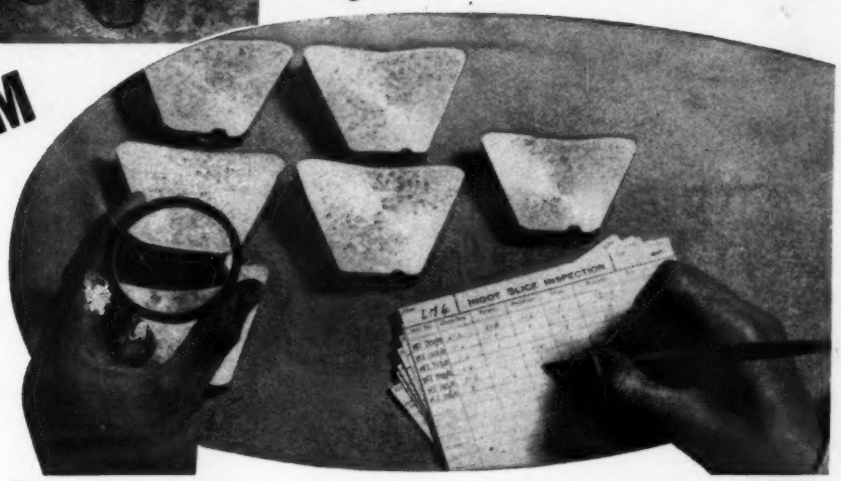

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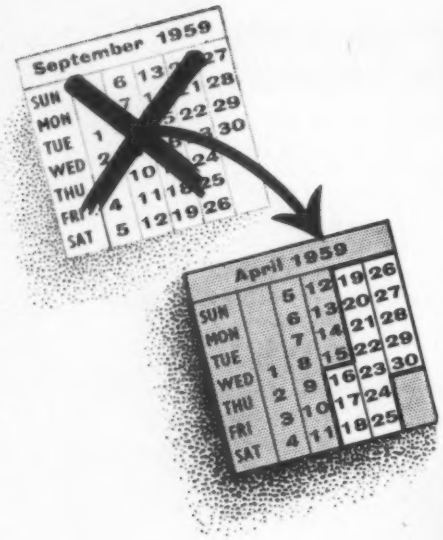

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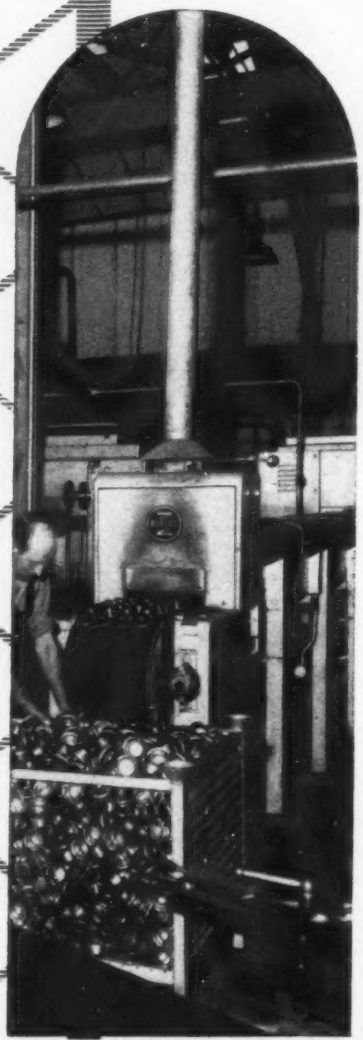

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METAL INDUSTRY

FOUNDED 1909

EDITOR: L. G. BERESFORD, B.Sc., F.I.M.

20 MARCH 1959 VOLUME 94 NUMBER 12

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VOLUME 94 NUMBER 12 20 MARCH 1959

Essential New Metals

FOR many years iron, aluminium, copper, nickel, zinc, and lead have been the main basic metals used for structural purposes, while the newer metals have been little more than laboratory curiosities and certainly not of industrial significance. The newer metals, however, such as titanium, zirconium, beryllium, and others, will soon become an essential part of the overall industrial scene. This was part of the picture presented by Dr. N. P. Inglis, research director of the Metals Division of Imperial Chemical Industries Limited last week when he delivered the 1958 Viscount Nuffield Paper before the Institution of Production Engineers at the Department of Mechanical Engineering of Birmingham University. The subject of his address was "The Production, Fabrication, Properties and Uses of Some of the Newer Metals."

Dr. Inglis pointed out that these "newer" metals, including also niobium, hafnium and tantalum, were none of them new in the sense that their existence had only recently become known. Titanium, for instance, was recognized in 1791 and isolated, in impure form, in 1825. Zirconium was recognized about the same time and isolated in 1824, while beryllium was recognized in 1798 and isolated in 1828. The existence of niobium was recognized by various scientists in the period 1801-44. It might very well be asked why these metals, which had been lying dormant for so many years, should now have become of such interest to practical engineers, and Dr. Inglis gives as the reason that new inventions, new designs, and new processes are calling for entirely new materials of construction. The discovery and development of nuclear energy, which can rightly be regarded as leading to a second Industrial Revolution, is playing a major part in stimulating effort in some of these new metals. Just as the development of the use of steam in railways and shipping rather more than a century ago necessitated a material of construction superior to cast and wrought iron and, therefore, fathered the manufacture of steel in gross tonnages, so the special requirements of nuclear engineering demand the availability of materials having certain special requirements.

The reason for the very real and active interest in the newer metals is simply that the advances of mechanical and physical science and practice definitely demands it and, as Dr. Inglis said, these metals are no longer solely of academic or subsidiary interest; they are now, or certainly will shortly be, an essential part of industrial production in many spheres, and will be among the available choices for the engineer and the architect when selecting the materials of construction to suit the requirements of their mechanism, structure, or whatever type of production with which they are concerned. These "newer" metals are no longer rare and, in fact, some of them are just as much in abundance as the more commonly used metals. The many fields in which these metals are now making their appearance as part of production processes is enough to indicate the widespread interest being taken in them, not only in the United Kingdom but in many other parts of the world, particularly in the United States where, in fact, new uses for these metals are being regularly found.

Out of the MELTING POT

Filament Casting

AT first sight, collection might well have been assumed to be the least of the problems connected with the process of producing a continuous metal filament by ejecting molten metal under pressure from a nozzle and rapidly cooling the emergent stream of metal. That this is not so, is suggested by claims for means of collecting a metal filament produced in this way, in which claims the design of the ejector tube and nozzle, and of means of chilling the filament, are taken for granted. One method of chilling the molten metal is to arrange for the stream to impinge at a suitable angle upon the concave surface of a rotating chill block. The solidified continuous filament formed by the stream on chilling in contact with the block is discharged from the surface by centrifugal force. The filament leaving the chill block is caught in the flared end of a guide tube which looks like an old-fashioned ear trumpet. A stream of compressed air is also directed into the receiving end of this tube to help carry the filament through the tube. On leaving the other end of the guide tube, the filament passes through another guide tube, which is reciprocated in a vertical direction. The filament, on leaving the lower end of this tube, is received and collected on the vertical interior wall of a rapidly-rotating collecting bucket, the rotation of the bucket and the reciprocating movement of the second guide tube resulting in the filament being formed into what, in the viscose industry, is known as a cake. In an alternative method of producing and collecting the filament, the stream of ejected metal is chilled by a stream of compressed air, carried into and through the trumpet-shaped guide tube by another air jet, and then deposited on a conveyor belt from a second guide tube, the delivery end of which is traversed to-and-fro across the belt. From the belt, the filament is lifted by guide rolls and carried to some device for winding it on a spool or bobbin. The metal filament is formed at speeds from 150 to 400 ft/sec. The size range, the properties, and the possibility of subsequent drawing or otherwise working such cast filament are all open to conjecture. Another matter requiring some fundamental consideration concerns the solidification of the filament: can some or all of the solidification occur in the nozzle (die) with sufficient pressure being applied to eject (extrude) the metal, assisted, in the case of complete solidification, by a pull on the emerging strand, or must solidification be delayed until after the metal has left the nozzle?

. . . In Hand

EVERY now and again, particularly in the United States, somebody gets into a panic at the thought that the source of basic scientific facts may eventually run dry. The panic does not, of course, show itself, but is rationalized into the view that, since the eventuality exists, it is reasonable that steps should be taken now to forestall it. The adoption of this attitude in place of the panic, is reflected in the familiar exhortations on the necessity for pure or fundamental research, in which exhortations, the drying up of the basic research data, if it is mentioned at all, is only referred to as something remote and in any case preventable. The all-too-familiar topic of the importance of fundamental research need not be pursued here. A much more intriguing question is: why the panic? On examination the reasons for it are not difficult to recognize. Rapid and continuous progress of numerous practical applications and developments, based on and nurtured by a reserve of fundamental knowledge, has become customary. Panic at the thought of this progress being halted is, therefore, understandable. Equally understandable is the next step of reasoning away this panic by homilies on the need for further research; understandable but not really reasonable. So far, nobody seems to have had the courage of facing up squarely to this panic in order to go on to examine the situation that would arise should the cause of this panic really take effect. So far, nobody has been realistic enough to turn from the comfortably vague vision of a never-ending chase of endless scientific frontiers to the simpler, more substantial, unlimited possibilities of really getting on and making full use of what we have already.

Less Skill

WITH no immediately apparent, not to mention large scale, outlets for the products as yet in view, interest continues in processes of manufacturing foamed metals. The first process to reach the commercial stage has now been in existence for some time. Used for aluminium and aluminium alloys, it depends on the addition of finely divided foaming agents (e.g. hydrides) to the molten metal, followed by casting of the metal immediately afterwards in order to trap the numerous bubbles of gas, released by the foaming agent, before they have had time to escape. Foamed aluminium made in this way can be cast into comparatively intricate shapes, a skin of reasonably smooth metal being formed where the metal comes into contact with the mould. The density of the foamed metal can be controlled between 12 and 70 lb/ft^3 (ingot aluminium—166 lb/ft^3). A wider range of foamed metals—what's in a name?—(e.g. copper, nickel, cast iron, etc.) is made possible by a more recent process which is similar to that for making thermosetting foamed plastics. An organic resin is mixed with a standard foaming agent which releases nitrogen or carbon dioxide. Metallic powder is added, and the mixture is baked in an oven. Heat releases the gas, which foams the metal to a point that depends on the predetermined amounts of materials. The result is a rigid foam with interconnecting cells. However ingenious and successful the above processes may be, they still leave one with the impression of being more of an art, and a skilled art at that, than production propositions. Since the foaming of a molten metal must of necessity be a transient phenomenon, it must be skilfully "secured" in batch treatment and production. The probably more promising alternative—foaming as a step in a continuous flow process—would consist of introducing the foaming gas into the molten metal in the course of a continuous casting process, the metal solidifying before the foaming gas has had time to escape, introduction being effected through porous walls, gas injection tubes, or by other means, including foaming agents. Having obtained the foamed slabs or billets, there would remain the interesting prospect of studying their behaviour in some of the familiar processes of producing semi-manufactured products, and the investigation of the properties of such products.

Skimmer

Finishing Supplement

Abrasive Sheets and Belts

By L. F. SPENCER

As industry becomes more concerned with the economics of finishing, attention is being turned to high quality abrasive belts, discs and other materials. This article, abridged from "Metal Finishing," deals with types of abrasives and chief factors affecting their operating efficiency.

ABRASIVE discs, sheet and belting are being widely used to replace other methods of grinding and polishing of metals, for instance, in the use of abrasive belts as a substitute for set-up wheels, offering advantages such as:—(a) an increase in the rate of metal removal; (b) a prior balancing of contact wheel that will result in maintenance of balance throughout its useful life; (c) the ability to change belts in a matter of seconds; and (d) the realization of a smoother operation with less effort.

Characteristics of Abrasives

There are five distinct and different minerals that are used in the manufacture of commercial coated abrasives, namely, (a) flint or quartz; (b) Turkish or American emery; (c) garnet; (d) aluminium oxide; and (e) silicon carbide. The characteristics of abrasives which are of most concern would include hardness, toughness and fracture type.

The hardness of an abrasive is a property that is difficult to define. However, it is frequently associated with the ability to penetrate the work surface to be ground or polished. The property of an abrasive to penetrate and continue to remove stock without a rapid breakdown is associated with toughness. Another important characteristic is the shape and type of sharp edge formed after the crude mineral is fractured or broken down through crushing to a desired grading. The cutting edges left after crushing play an important part in the use of the abrasive; this characteristic frequently is identified as the fracture pattern of the abrasive. A classification of the five abrasive types as to relative hardness, toughness, and fracture type is given in Table I.

Emery is a natural mineral of sufficient hardness for use in the abrading of metal surfaces; however, the characteristic round and blocky fracture with poor cutting edges, along with the absence of concave sides for chip clearance, limits its use as an abrading material. It will, however, produce a higher polish, when used in conjunction with a lubricant, than the artificial minerals, aluminium oxide and silicon carbide.

Crocus is an iron oxide which has only a mild abrasive action, and frequently is confined to developing a polished metal surface. It is used with oil and, under high pressure, will produce a lustrous finish on a previously prepared metal surface.

Aluminium oxide is the most widely used abrasive grain in the form of coated abrasive discs, cloth and paper belts, and hand sheets. It is harder than emery though not quite as tough.

Aluminium oxide, which is fourth in hardness to the diamond, is capable of penetrating practically any commercial type of metal. It is extremely tough and, therefore, resistant to wear. This artificially prepared mineral, when crushed to the desired grit size, has a blocky or regular crystal shape, usually described as a heavy wedge, that makes it ideal for the cutting of harder metals. The heavy shoulder supporting the short edges gives it toughness.

Silicon carbide, which is third only to the diamond in hardness, has the most ideal fracture for coated abrasive purposes and its use is limited only by its relative brittleness. It has sharp cutting edges, which provide rapid stock removal with a minimum of frictional heat. Its relative brittleness permits a rapid wearing action, particularly when it is used for abrading high tensile strength materials, which makes it frequently too costly in applications such as this.

In abrading metals, silicon carbide abrasives are used on the soft and ductile metals such as pure aluminium, brass, bronze, and lead castings. It is also used for the final polishing operation in wide belt polishing of sheet steel. When abrasive minerals with cutting shape or fracture having less concave sides for chip clearance, with shorter, duller edges than those of silicon carbide, are used on these and other soft "greasy" metals, the results are apt to be as follow: the duller minerals will cause the ductile surface to flow and, with increased frictional heat due to the lack of free cutting, rapid loading between the cutting crystals will take place, thus minimizing the cutting action. On the other hand, since the lack of toughness of the silicon carbide abrasive is not a disadvantage in abrading these soft metals, the hard and sharp fracture of this abrasive type will cut these materials freely, leaving a better finish and, in addition, will last longer.

In selecting an abrasive, the general rule that is usually followed is the selection of aluminium oxide abrasives for the harder metals and alloys, whereas the silicon carbide abrasives are used for the soft or "soft greasy" metals.

It also should be remembered that coated abrasives actually have little in common with built-up or bonded abrasives. Accordingly, the rules in the use of bonded wheels frequently are not applicable as a guide in the selection of coated abrasives.

In many respects, the backing is as important for the job as the mineral type selected. For metal sanding, where sharp edges, burrs or fins would be apt to rip or dig the backing, cloth is generally used, due to its higher tensile strength. However, paper, because of its lower price, is frequently used on certain types of metal working, such as light sanding, metal clean-up, and the polishing of sheet metal.

Coating Types and Adhesives

There are two types of mineral coatings, namely, the closed or regular coat and the spaced or open coat.

The open-grain coating is non-clogging in that the material abraded will free itself quite readily from the belt. Accordingly, this coating type is preferred for the sanding of varnish, shellac and enamel surfaces, for the removal of paint, and for the sanding of soft, gummy surfaces. Since the open-grain coat is more flexible, it is preferred for irregular contours within the work. The closed-grain coat is adapted to the sanding of hard metals, hard wood, and other non-filling materials where heavy pressures and rugged stock removal are required.

TABLE I—CHARACTERISTICS OF ABRASIVE MINERALS

Mineral Type	Hardness	Toughness (per cent)	Fracture Type
Flint	6·8 to 7·0	20	Light wedges
Garnet	7·5 to 8·5	60	Light wedges
Emery	8·5 to 9·0	80	Round and blocky
Aluminium oxide	9·4	75	Heavy wedges
Silicon carbide	9·6	55	Sharp wedges and silvery

The Moh's scale of hardness is used, on which the diamond rates a value of ten while the softest mineral, talc, has a rating of one.

TABLE II—RECOMMENDED SPEEDS

Material	Speeds surface ft/min.	General Remarks
Mild Steel	5,500-7,500	Heavy grinding applications
	7,500-10,000	Polishing applications
Aluminium, zinc, copper and some copper base alloys, die-castings	9,000-12,000	Generally used in conjunction with a grease-stick or other suitable lubricant
Grey cast iron	12,000	
High tensile steel alloys		Determined experimentally. Require much lower speeds and are very sensitive to speed changes. Slight changes in composition, or, changes of 500 surface ft/min. on either side of the optimum speed for a specific alloy may result in as little as 50 per cent belt efficiency

Since the materials sanded have a high tensile strength, and thus minimize clogging, a continuous cut at a constant rate is experienced, with a relatively long life of abrasive disc or belt.

The conditions under which abrasive paper is stored may affect the subsequent performance of this material. The product consists of a backing material, an adhesive and an abrasive; the first two components are sensitive to climatic conditions, and will gain or lose moisture in accordance with the relative humidity.

To prevent deterioration in storage and to ensure the proper service in use, paper should be stored in a room held at reasonably constant temperature and relative humidity. The temperature should be between 60° and 80°F., while the relative humidity should be around 50 per cent.

Operating Variables

There are a number of variables that will have an effect on a grinding or finishing operation which should be recognized and considered. Although there may be exceptions to the general observations that will be given, it is believed that a knowledge of these variables and their effects will help those who are considering the application of abrasive belts.

In regard to minerals, the finer the grit the finer will be the finish. In choosing an adhesive bond, the harder the bond the coarser will be the finish. Resin-bonded products will produce coarser finishes than the glue-bonded products. The heavier the pressure, the coarser will be the cut.

Belt Speed. This is normally expressed as the number of feet a given point on a belt will travel in a minute. With all other factors being equal, a higher belt speed will generally:—(a) improve the finish, due to less penetration and "cleaner" chip break-away; (b) reduce glazing, since the greater shock to the grain tips will encourage sharpening and fracturing; (c) reduce loading, due to the higher centrifugal force when the belt reverses itself at the idler; and (d) increase rate of stock removal, due to the greater number of cutting tips that will contact the work per minute. Table II gives a guide to proper belt speeds; however, experimental work may be required in considering the variables under discussion.

Contact Wheel. Contact wheels, which back up the belt, are selected according to the material and hardness best suited for the job. Normally, the harder the contact wheel the coarser will be the finish. Rubber-covered wheels usually produce better belt efficiencies than other wheel types. The softer wheels (Durometer 10-30) are used for fine polishing and contour grinding; the medium-hard wheels (Durometer 30-60) are for normal polishing operations to obtain a reasonable finish; and the hard wheels (Durometer 60-90) are used where an increased cutting action is required. Serrated rubber wheels, as compared to the solid type previously discussed, usually produce the fastest cut and permit a longer belt life. Normally, the greater the separation between the lands on a serrated contact wheel the more aggressive will be the cut, and, consequently, the coarser will be the finish. Cloth contact wheels, as exemplified by compressed canvas and full-disc wheels, are also used; the advantage of the former type being factory-formed wheels to a customer's template or workpiece. As to contact wheel diameter, the larger diameter will realize the finer finish.

Lubricants. Lubricants will generally produce a finer and more uniform finish, reduce heat generation at the contact point, and prevent loading and subsequent glazing of work. The effectiveness of a lubricant is determined by the viscosity at the contact point, the heavier viscosity giving the better finish. Compounded oils are being used increasingly, particularly as a fine spray or mist on automatic and semi-automatic equipment. Oil lubricants are particularly effective in the polishing of non-ferrous metals where glue-bonded cloth belts are employed. The resin-bonded wheels do not respond nearly as well since they are not as porous as the glue-bonded belts.

With all other variables being equal, the finish on materials is difficult to assess. However, for efficient production it may be necessary to change some of the variables to suit the material. If one were to use the axiom that, as the rate of cut decreases, finish improves, the harder materials would seemingly receive the finer finish. On some soft materials, however, finish may not be entirely a matter of scratch pattern, as the temperature at the point of contact may be such that the material will plasticize and actually achieve a finer finish than the normal scratch pattern.

Feed Direction. The direction of feed will influence the type of cut. A feed against the belt rotation will produce a coarser cut than when the material is fed in the direction of belt rotation. Belt wear tends to decrease the size and sharpness of the abrasive grains and, as a result, will decrease the depth of penetration. Consequently, it will produce a finer finish as the belt wears.

Flexing. Although flexing is a very important step in the manufacturing process, the user frequently does not have a complete understanding of this vital operation. Flexing may be defined as a controlled and uniform cracking of the glue and resin adhesive bond to facilitate ease of handling. The degree of flexing is a function of the end use of the material.

Coated abrasives, as they come from the drying ovens, are stiff and brittle, particularly in the coarser grits. All coated abrasives have two adhesive coatings: the first a "maker" coat, in which the grain is embedded, and the second a thin "sizing" coat, which surounds each grain and anchors it to the maker coat. When these adhesive coats dry, or are "cured," they form a hard, rigid layer tightly gripping both backing and abrasive grain. The flexing process, which is performed on special equipment, minutely and uniformly cracks this adhesive layer in such a way that the continuity of the coating is broken so that the finished product will bend or roll easily.

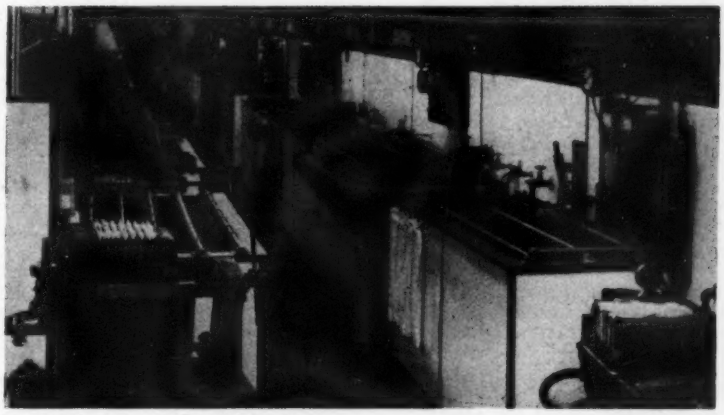
While there are four basic standard flexes, some items require none, a typical example of which would be garnet, and silicon carbide coated finishing paper. Other things being equal, it is generally true that the material having the least flexibility necessary to do the job will cut fastest and last longest. Single-flexing is a mild flexing across the web at an angle of 90°. The majority of cloth and paper products are single flexed, particularly the coarser grits.

Double-flexing is achieved by pulling the material under tension over steel flexing bars set at an angle of 45° in opposite directions. Paper products are never double-flexed, and a comparatively few cloth products are treated in this manner. However, resin-bonded aluminium oxide cloth products from grit 320 to 80 are double-flexed. Triple-flexing consists simply of a combination of single and double flexing, i.e. a 90° flex plus two 45° flexes. The extreme triple-flexing is obtained for special uses by giving a triple-flexed material an additional 90° flex, using a combination of heavier tension, a more severe angle of pull, and a special shaped flexing bar.

Plating Research Centre

INCREASED facilities for research and development in electrodeposition have been provided by a new Technical Centre opened this week by W. Canning and Co. Ltd., at Great Hampton Street, Birmingham. This enables the various analytical, metallurgical, service and lacquer laboratories to be assembled together with a fully equipped plating department for demonstration and research purposes.

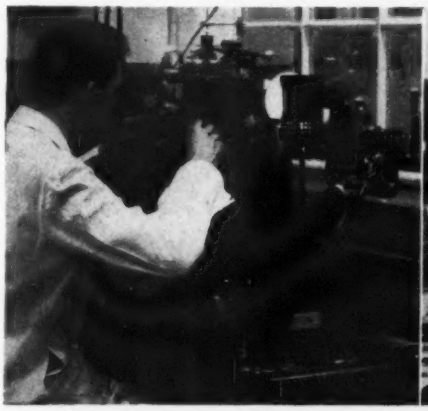
The main plating shop is situated on the ground floor, with the tanks arranged in two parallel rows, barrel plating equipment with separate rectifier control being adjacent, as also the polishing room and barrel finishing sections. In accordance with modern practice, fume extraction has been provided by exhaust ducting from the lip of the tanks, the ducting being carried downward and connected to main trunking under the flooring of the shop. The tanks and controls are cased in plastics, the tops of the tanks having a common level, the whole appearance and design of the plating shop being both modern and clean, providing ideal working conditions.



Part of the Demonstration Plating Shop

The main laboratories are housed on the first floor, together with the executive offices and Service Chemists Department, and an instrument room furnished with the latest research apparatus. Separate lacquer laboratories have been provided for lacquer development. On the top floor there is a lecture theatre, equipped with a 16 mm. projector and sound equipment.

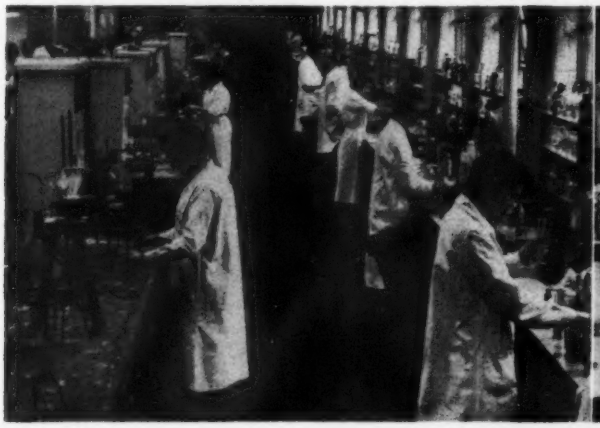
In the basement a photographic department, with suitable air conditioning and a well equipped dark room, has been installed.



Vickers Projection Microscope in the Instrument Room

A part of the Lacquer Laboratory

The General Analytical Laboratory



View of the Service Laboratory

Products and Processes

TRENDS IN THE DEVELOPMENT, APPLICATION, PROCESSING, DESIGN AND WORKING OF NON-FERROUS METALS AND THEIR PRODUCTS

Thermal Insulation for Factories

REGULATIONS which came into force in January compel a certain standard of thermal insulation for all new industrial buildings. Fuel economy also demands a high degree of thermal insulation, and modern adhesives enable a choice to be made between thermal insulation boards, metal foils, foil/paper laminates and expanded polystyrene. They also provide a ready means of fixing insulating panels.

One of the most suitable adhesives for this purpose is "Evo-Stik Impact" adhesive 528, a product of the Industrial Adhesives Division of Evode Limited. This is a one-part single-solution synthetic cement, which is applied to both surfaces to be joined and allowed to dry for 15 min. After this time, although the surfaces feel quite dry to the touch they will make a permanent bond immediately they are brought together. It is not always necessary to coat the entire surfaces, depending on the size and weight of the panels and whether or not excessive condensation occurs in the building. For expanded polystyrene insulation a special adhesive, "Evo-Stik RD 712" is recommended.

Vapour Blasting

BUILT almost entirely from plastics materials, a new type of vapour blasting equipment is now being marketed under the trade name "Hydrotron" by Meta-chemical Processes Limited.

The Hydrotron is fabricated from Vybak industrial rigid P.V.C. sheet made by Bakelite Limited, and comprises basically a Vybak blasting cabinet and supporting structure, beneath which is located a large polyethylene container for holding the abrasive slurry. Compressed air is used to displace the slurry from the container to the blasting gun housed in the cabinet. Other design features include a rigid P.V.C. extractor unit with nylon impeller, built-in rubber sleeves to protect the operator's hands, and an automatic washing device for the observation window.

A number of important functional advantages are claimed for the Hydrotron. For example, the abrasive within the slurry cannot be contaminated by the rigid P.V.C. used in the construction of the equipment, and abrasives, or grades of slurry, can be altered in a moment merely by changing to another polyethylene container. The speed of the particle is higher than with any other known equipment, and the slurry feed system and working cabinet can be quickly and easily washed down when changing from one metal or slurry to another.

Almost every cleaning or etching technique can be replaced by this new method, and all metals that are in any way capable of being plated can be prepared by Hydrotron blasting. The equipment is regarded by its designers as essential for depositions on molybdenum, uranium, titanium or magnesium alloys.

Remote Control for Air Motors

UNTIL remote control was devised for air motors, forward, neutral and reverse operation had to be hand-controlled on the motor itself. Control equipment, now introduced and manufactured by Maxam Power Limited, one of the Holman group of companies, controls the forward and reverse operation, in addition to controlling a cylinder-operated brake on hoists and winches, etc.

The remote control equipment for each Rotomotor unit, as the Holman units are known, comprises a hand-operated lever valve situated on the control panel and, in the motor, a rack, actuated by duplex pistons situated at each end, which engages a pinion on the reversing valve. In the neutral position, compressed air is applied to both ends of the duplex pistons, and the reversing valve shuts off the air supply to the vanes of the rotor. In the "forward" position

Left: Hydrotron vapour blasting unit fabricated from Vybak PVC sheet

Below: Close-up through the observation window of the Hydrotron unit installed at one of the research laboratories of D. Napier and Sons, Luton, where it is being used for cleaning aluminium and copper foil

pressure is released from one side of the duplex piston, allowing air to pass to the vanes of the rotor. Choice of "reverse" hand-operated lever valve position moves the duplex piston into reverse, which changes the direction of air to the rotor.

The reversing control valve can be either a single lever-operated valve or two push-button types which automatically assume neutral upon release. A lever control valve can be fitted which also reverts to neutral upon release. Limit switches can be placed between load and motor to limit movement and prevent over-run in either direction. Provision is made on the motor for a valve to control the supply of air to a spring-operated air release brake cylinder when required.

Where very fine control or inching is necessary, a Maxam slow lowering control valve is supplied.

Measuring Pouring Temperature

A RADIATION pyrometer which measures the temperature of metal, as it leaves the furnace, with an accuracy comparable to that of an immersion pyrometer, has been introduced by Land Pyrometers Ltd.

By using a photocell instead of a thermopile, the manufacturers have successfully eliminated the serious effect of metal emissivity on the accuracy of the reading—the main drawback of previous radiation pyrometers introduced for this purpose.

Calibration is for the normal emissivity of a liquid metal stream, and the small variations encountered in practice have only a negligible effect on the readings.

The R.P.18, as it is styled, can be focused on a target as small as 1 in^2 and is, therefore, easily sighted on the metal stream. The pyrometer lens is protected by a window of heat-resisting glass, which can easily be cleaned or replaced if accidentally splashed with metal.

To avoid damaging the photocell, a water jacket is supplied with the instrument in order to keep its temperature below 40°C. The pyrometer is easily clipped into the jacket with an accurately reproducible alignment.

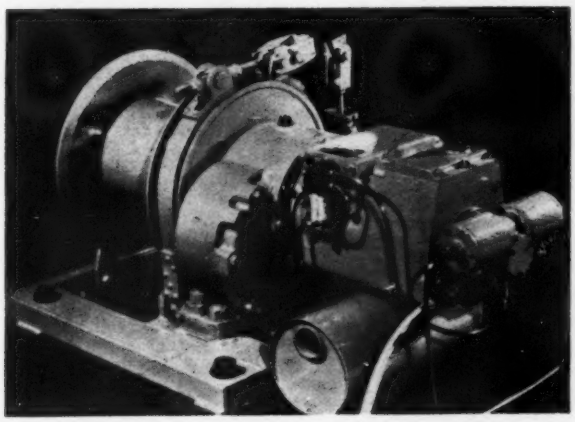
Another integral part of the equipment is an air purge unit, which enables an air jet to be blown down the optical path to keep it free from fumes. This also helps to protect the pyrometer window.

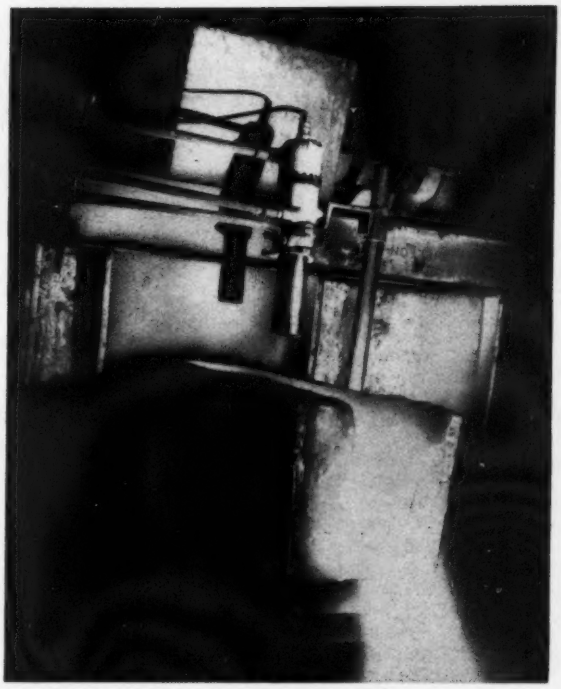
Improving Arc Melting Efficiency

AN extension to their range of large diameter taper jointed electrodes has been made by British Acheson Electrodes Limited, who have now introduced 16 in. and 14 in. diameter graphite electrodes with taper jointing to join the well-established 20 in. taper jointed electrodes.

Right: Electrode socket showing the large diameter taper joint

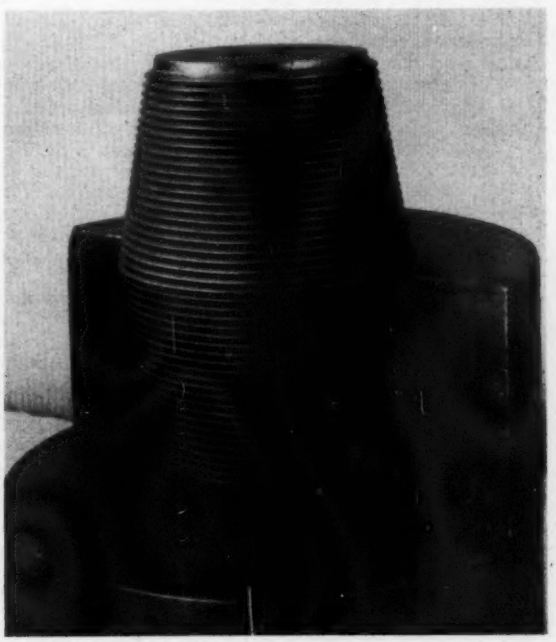
Below: Remote control equipment on a Holman 7R Rotomotor, with duplex cylinders at extreme right





The Land R.P.18 pyrometer fitted above the pouring spout of a melting furnace

The new 16 in. diameter electrode has a nipple with a major diameter 8¾ in. and length 12 in. This means a thicker socket wall all round, in addition to the extra protection and life given to the socket by the 1 in 6 taper. The new 14 in. diameter electrode is machined to take a nipple 8 in. at the major diameter and 10 in. long. This again means a thicker socket wall. For maximum security and tightness of joints, the threading of nipple and socket is 4 threads/in. machined to fine tolerances to ensure perfect matching of tapers. Shortly to follow the new 14 in. and 16 in. diameter electrodes will come 12 in. diameter electrodes.



Atomic Progress

Swelling of Irradiated Uranium

CURRENT designs of civil fuel elements are based on magnesium-canned uranium. It is difficult to make precise estimates of the maximum irradiation life to which they can be used satisfactorily; reactivity changes in the fuel seem unlikely to limit the useful life of these fuel elements, and one is left to consider the effects of metallurgical changes. The swelling that occurs when uranium is irradiated at temperatures above about 500°C. is of great importance in this connection. Swelling can also be produced by heating uranium irradiated at low temperatures, and a recent Paper[1] by A. T. Churchman, R. S. Barnes, and A. H. Cottrell describes some out-of-pile experiments related to this problem. Although closer control is possible in out-of-pile work, this Paper shows that the swelling produced during irradiation is associated with a different dispersion of fission product gases.

Gas Pockets

Volume increases of 10-50 per cent (i.e. swelling) occur when uranium is irradiated above 500°C. It is known that this increase is not caused by lattice expansion. Many holes appear in the microstructure after irradiation, and the swelling is thought to be caused by separation of fission product gases into pockets or bubbles, since about 2 c.c. (NTP) of krypton and xenon are produced per c.c. of uranium during irradiation. In the experiments of Churchman *et al* the effects of fission gas have been separated from those of irradiation and more precise control gained over the conditions of heating than is possible during irradiation. This was achieved by taking uranium irradiated in the N.R.X. reactor, Chalk River, to a maximum burn-up of 0·4 per cent at a temperature below 300°C., where swelling does not occur, and subsequently heating it at various temperatures and pressures to produce structural changes. Deductions from radioactive decay sequences showed that the specimens contained 70 per cent of the initial fission gases, whilst mass spectrographic analysis confirmed the presence of krypton and xenon as the major constituents of gases released from two specimens on melting.

The authors found that the amount of swelling produced increased with the annealing temperature above 450°C. Below this temperature no swelling was detected; at 575°C. there was 2 per cent swelling; 4 per cent at 800°C., and 20 per cent above 1,000°C. At 575°C. and 800°C. most of the swelling occurred in the first few hours of heating. An applied pressure of 6,000 lb/in² led to considerable reductions in the observed swelling at 575° and 810°C., but at the higher temperature the effect was only temporary. Subsequent heating at low pressures often resulted in large swellings. It was also found that swollen specimens could be compressed partly to their original size by heating under high pressure, and the authors state that the changes produced by alterations in pressure are nearly reversible. Neither cyclic changes of pressure at constant temperature, nor thermal cycling through the phase transition, produced large swelling. The authors found that large swellings could be produced in three ways:—(1) By heating to high temperatures under low pressure, (2) by reheating under low pressure after heating under high pressure, and (3) by heating above 800°C. after thermal cycling between room temperature, and 575°C. if not heated to 800°C. before cycling.

The observation of holes in the heated specimens and the almost reversible effect of pressure are evidence that the swelling is caused by gas pockets. Approximately spherical holes, varying from 100μ to 0·2μ diameter, were observed in numbers ranging from 10^3 per c.c. to 10^{13} per c.c. respectively. It was concluded, therefore, that most of the swelling is caused by the smaller holes. Some cracks were also noted which were thought to have been initiated at impurities. Two specimens which shattered at room temperature showed severe intergranular fragmentation.

Theory

Churchman and his colleagues calculated the gas pressure in bubbles for various volume increases, and deduced an effect of pressure roughly in agreement with the results. They found that surface tension exerts a strong restraining force on swelling, and deduced a bubble radius of about 0·15μ, which is in agreement with the observed size of the most abundant bubbles.

Theoretical calculations of the swelling at 575°C. did not account for the observed swelling, and it appears that lenticular shapes, as well as spherical bubbles, may be involved. This, the authors note, is also suggested by the strong effect of pressure at this temperature. Anisotropy of the uranium lattice should also favour the formation of non-spherical bubbles.

At 810°-835°C. the authors believe that large swelling arises because some of the gas bubbles become connected by cracks, particularly since extensive cracking occurs after thermal cycling. The fact that the specimens eventually fail to respond to pressure is interpreted by the authors as suggesting that much of the swelling is contributed by cracks, which eventually run to the surface of the specimen.

Swelling During Irradiation

The spacing and size of bubbles produced in uranium heated after irradiation are smaller than those produced when it is heated during irradiation. This difference is explained by the authors in terms of the theory of nucleation. During low temperature irradiation a supersaturated solution of fission product gases is produced in the uranium. Diffusion of the gas atoms increases as the temperature is raised, and eventually leads to fine scale precipitation and the formation of large numbers of small bubbles in which the gas is severely restrained by surface tension. Because these bubbles are so numerous, cracks, inclusions, and other pre-existing large nuclei, are prevented from capturing more than a small proportion of the gas atoms. However, when the gas atoms are created at temperatures where diffusion can occur, they are able to migrate to inclusions, cracks, etc., before more gas atoms are created nearby. Consequently, the gas atoms separate out to form large bubbles unrestrained by surface tension forces.

Swelling during irradiation will impart strain on fuel element cans and is a potential source of failure. Whilst all the experimental evidence indicates that the magnesium canning alloy employed in the first civil nuclear power stations can accommodate at least 40 per cent volume swelling, there is naturally great interest in methods of minimizing the swelling that is to be expected during irradiation of metallic uranium fuels.

Theoretically, it appears possible from the work of Churchman *et al*[1] to reduce swelling by providing fine scale nuclei in order to take advantage of surface tension restraint in small bubbles produced as a result of heterogeneous nucleation. Unfortunately, it is not clear that nuclei of the required spacing and size (less than 10^{-5} cm.) can be produced which will remain stable under irradiation. It is also possible that homogeneous nucleation may occur at sites such as dislocation nodes. The elimination of large inclusions might also increase the stability, since Churchman *et al* show that at least some of these larger inclusions nucleate cracks which contribute to swelling. Another alternative, of academic interest where magnesium canning is involved, is the application of strong external forces to restrict swelling.

(*Continued on page* 232)

PROCESSES AND METHODS FOR WORKING HIGH TEMPERATURE MATERIALS

Fabricating High-Strength Superalloys

By H. E. HALEY

(*Concluded from* METAL INDUSTRY, 13 *March* 1959)

FOR lining vessels with the nickel-molybdenum or nickel-molybdenum-chromium alloys, the welding techniques illustrated in Fig. 3 have been used.

In the more severe corrosion applications, methods B. C, and D have proved most satisfactory because they eliminate any possibility of base-metal dilution. Method B is excellent for position welding because the overlap forms a ledge which facilitates deposition of the weld metal. As a result, this type of weld can be made in the field, as well as in the shop. Methods B, C, and D are economical, too, because the welds which are not exposed can be made with stainless steel rod, or without the addition of filler rod, by using the inert-gas-shielded arc process to melt down the edges. Method D is a modification of method C with wider spacing between the bottom strips. Wider spacing, however, results in a less rigid structure.

The previous discussion related to the edge welds only. The end butt welds are generally vertical and should be staggered as illustrated in the sketch (Fig. 3). When using methods B, C, and D, the butt welds should not be bonded to the base metal, but care should be taken to obtain as deep penetration as possible without causing dilution of the alloy weld bead.

Methods A and E are also satisfactory if care is taken in making the final cover weld to prevent base-metal dilution. These are both flat position welding methods, however, and should be made in a shop where suitable fixtures and jigs for turning the vessels are available.

The end butt welds for methods A and E are made using the same technique as is shown for the edge welds. These end welds may either be made by vertical "up" or vertical "down" welding techniques, whichever is preferable.

Forming

All these alloys tend to work-harden to a greater extent than do the austenitic stainless steels and, as a result, require more intermediate stages of deep drawing or cold forming to produce the final part. Again, a study of the mechanical properties of the alloy will be invaluable in establishing processing and in designing tooling. In Fig. 4 are shown yield strengths of the typical superalloys in comparison to type 310 stainless steel. It is quite obvious the higher yield strengths will require greater pressures to deform the superalloys. It should be noted that the yield strength does not drop off appreciably before a temperature of approximately 760°-870°C. is reached. The 20-25 per cent decrease in yield strength at temperatures up to 430°C. or 540°C. is generally not sufficient to warrant hot working in this lower temperature range. Referring to the ductility curves again (Fig. 2) will also show that it is impracticable to hot work in the temperature range of 540°C. to 980°C. because of the "hot-shortness" of the alloys. Because of the difficulty of maintaining temperatures above 980°C. for press forming, deep drawing or

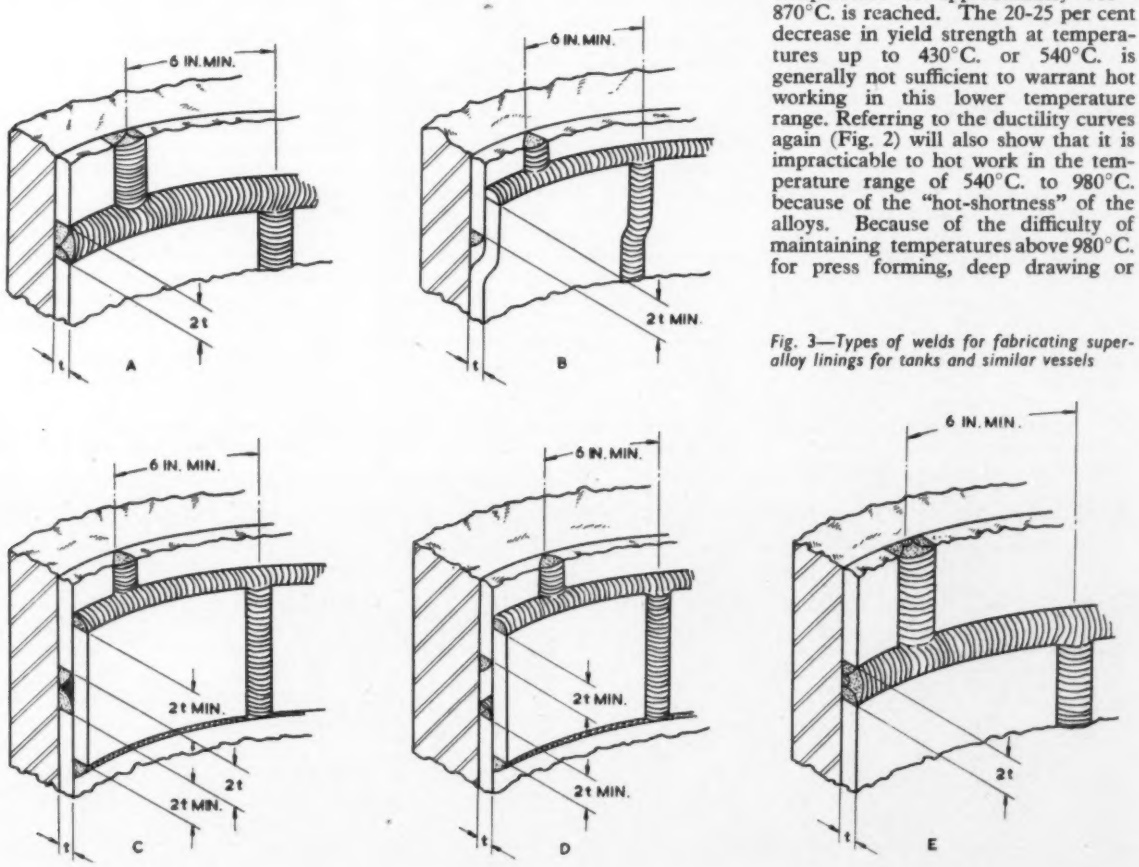


Fig. 3—Types of welds for fabricating superalloy linings for tanks and similar vessels

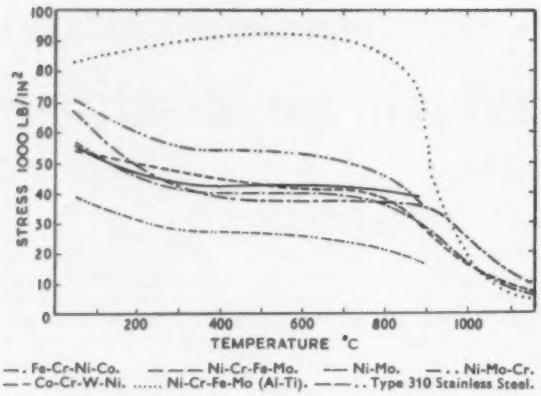


Fig. 4—Yield strengths of typical superalloys compared to type 310 stainless steel

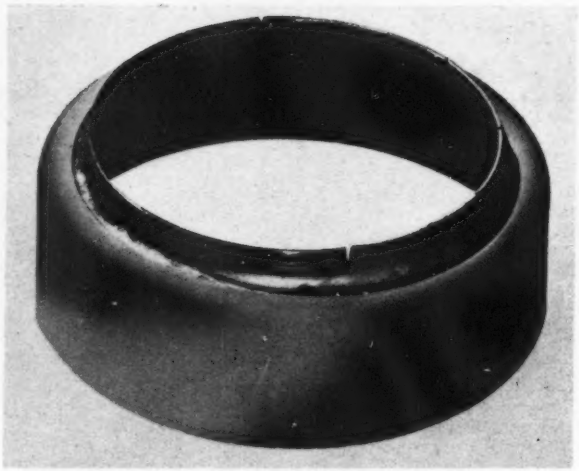


Fig. 5—Aircraft part deep drawn from Co-Cr-W-Ni alloy, showing defects in skirt area due to low temperature of intermediate anneal

TABLE VI—SOLUTION HEAT TREATMENT

Alloy	Temperature °C.	Cooling Method
Fe-Cr-Ni-Co	1180	RAC or WQ
Ni-Cr-Fe-Mo	1180	RAC or WQ
Ni-Mo	1180	RAC or WQ
Ni-Mo-Cr	1230	WQ
Ni-Cr-Fe-Mo (Al-Ti)	1200	WQ
Co-Cr- W-Ni	1230	RAC or WQ

RAC—Rapid Air Cool.
WQ—Water Quench.

spinning, it is recommended that these operations be done cold. Forging is done hot, as will be explained later.

Heat-Treatment

Each successive cold forming operation should be followed by an anneal at the solution heat-treatment temperature, as shown in Table VI. It is also highly desirable to remove scale by pickling the part prior to the next forming operation. All parts should be annealed at the solution heat-treatment temperature after final cold forming. If the dimensions and accuracy of the finished piece make the final heat-treatment impracticable, the following procedure may be used:

(1) Form as near to completion as possible, preferably a minimum of 90 per cent of the finished shape. (2) Anneal at the solution heat-treatment temperature. (3) Pickle. (4) Perform the final sizing operations.

It is important to note that temperatures below those recommended for solution heat-treatment do not restore full ductility. This was emphasized by the recent experience of an aircraft parts fabricator when a problem was encountered in the fabrication of a press-formed part of a cobalt-chromium-tungsten-nickel alloy. The recommended solution heat-treatment for this material is 1,230°C. Circular blanks 6¼ in. diameter were punched from 0·050 in. thick sheet, and in the first drawing operations a cup 4¼ in. diameter and 1¼ in. deep was produced. The part was then annealed for 2 min. at 1,180°C. (40°C. below that recommended), after which the "hold-down" flange was removed and a hole approximately 2 in. diameter punched in the bottom. In the second drawing operation, the bottom of the cup was flared down to produce a skirt approximately ½ in. long. It was at this point that cracks developed in the skirt area, as shown in Fig. 5. Hold-down pressures were varied from 15 to 80 lb. and other drawing procedures were tried without success. The part was produced successfully only after the intermediate heat-treatment temperature was increased.

A number of tests were conducted to show the effect of the heat-treatment temperature on this cobalt-chromium - tungsten - nickel alloy. Samples were prepared from 50 per cent cold-reduced material, and from mill-annealed material. Bend tests were conducted after material in both conditions was heat-treated for 10 min. at temperature increments of 40°C. from 980°-1,090°C., and 30°C. increments from 1,090°-1,200°C. Although it is difficult to distinguish the minor cracks in the macrophotographic reproduction (Fig. 6), the bend tests showed conclusively that cracking took place in all samples at annealing temperatures below 1,200°C. This test not only shows the effect of temperature in removing the stresses of cold work, but also shows the ageing effect of these temperatures on the mill-annealed material.

Room-temperature tensile tests of 50 per cent cold-reduced material heat-treated at temperatures of 1,150°C., 1,180°C and 1,200°C. for 2, 10 and 30 min. show the effect of temperature and time at temperature on yield

TABLE VII—EFFECT OF HEAT-TREATMENT TEMPERATURE ON 50 PER CENT COLD REDUCED Co-Cr-W-Ni ALLOY

Condition	Rockwell C Hardness	U.T.S. 1000 lb/in²	Yield Strength 0·2 per cent Offset 1000 lb/in²	Elongation per cent in 2 in.
As Cold Reduced	50	297·0	—	1·0
2 Min. at 1150°C.	38	179·0	116·5	25·0
10 Min. at 1150°C.	34	169·5	105·0	31·0
30 Min. at 1150°C.	35	166·5	91·5	42·0
2 Min. at 1180°C.	34	166·0	97·0	43·0
10 Min. at 1180°C.	27	159·0	82·0	48·0
30 Min. at 1180°C.	32	150·0	74·0	51·0
2 Min. at 1200°C.	21	148·0	74·5	47·0
10 Min. at 1200°C.	97*	146·0	73·5	59·0
30 Min. at 1200°C.	72*	141·0	69·0	53·0

**Rockwell "B".*

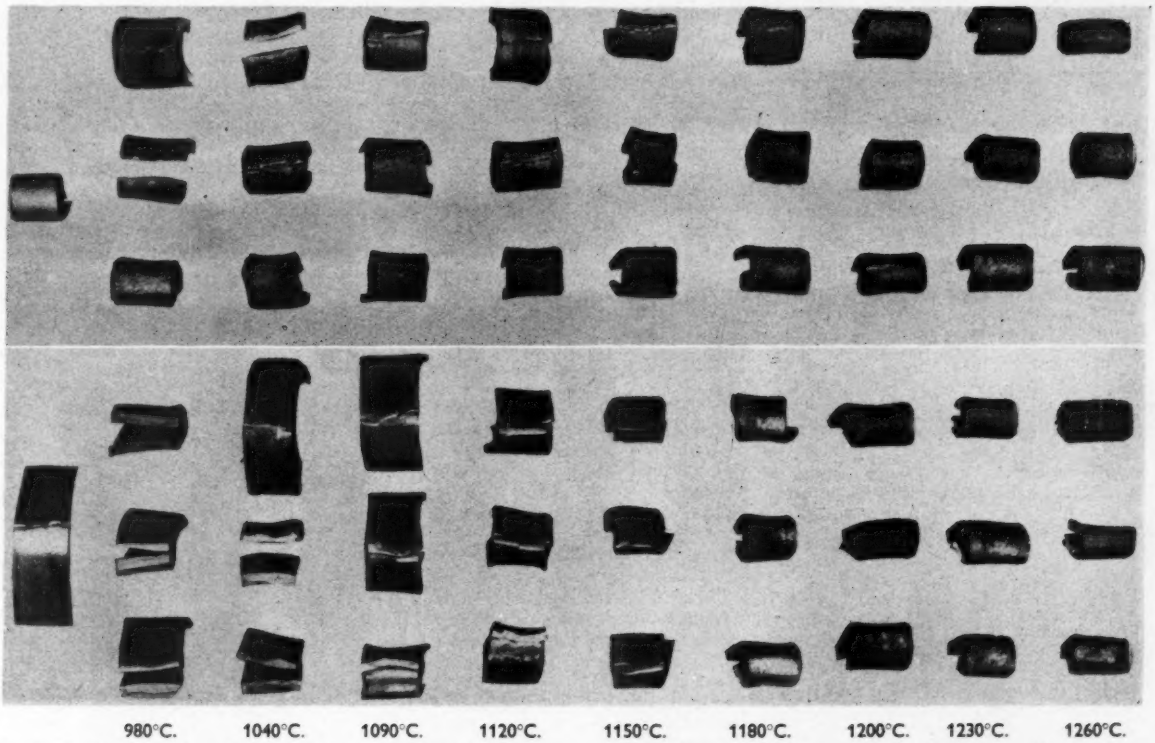


Fig. 6—Bend tests showing effect of heat-treatment temperature on 50 per cent cold reduced and mill annealed Co-Cr-W-Ni alloy. Hot-rolled and mill annealed (top) 50 per cent cold reduced (bottom)

strength and ductility. This information is shown in Table VII. In the series of tests depicted in Fig. 6 and Table VII, the optimum temperature was not employed because of the limitations imposed by the fabricator's heat-treatment equipment.

Photomicrographs (100×) of the cobalt-chromium-tungsten-nickel alloy in the mill-annealed condition, as well as in the 50 per cent cold-reduced, and cold-reduced and annealed conditions, are shown in Fig. 7.

Descaling

Because of their high alloy content, these superalloys are relatively inert to cold acid pickling solutions. After heat-treatment, the oxide film is more adherent than that on stainless steels. Molten caustic baths, followed by warm acid pickling, have been found to be most efficient. Both the "Virgo" (Hooker Electrochemical Company) and "Sodium Hydride" (E. I. du Pont) methods have also been successful. Some slight variations in the bath temperature and time in the bath may be necessary to adjust for variations in chemistry within an alloy group. The "Virgo" caustic bath is followed by a water quench which washes the caustic solution from the metal. For chromium-bearing alloys, the water quench is followed by a 3 min. sulphuric acid dip and then a 25 min. nitric-hydrofluoric acid dip, while non-chromium bearing alloys are given a 25-45 min. sulphuric acid dip only. The time will vary with the caustic bath employed as well as with the alloy. Moderately good results have been obtained by pickling the cobalt-chromium - tungsten - nickel alloy in dilute aqua regia.

Forging

It is highly important that billets of superalloys are properly soaked before forging. Billets can be charged into the furnace at room temperature, then

Fig. 7—Photomicrographs showing general microstructure of Co-Cr-W-Ni alloy after 50 per cent cold reduction (left) and the same material after a solution heat-treatment of 1230°C. for 10 min. (right). ×100

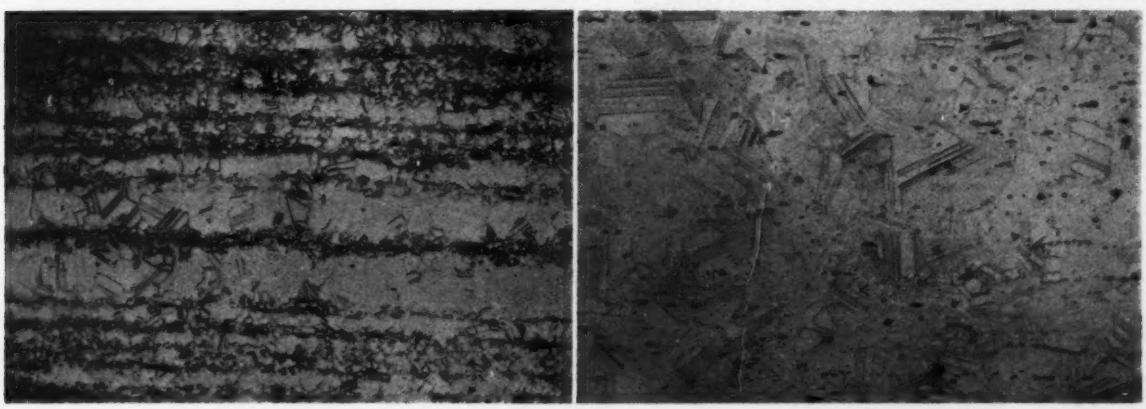


TABLE VIII—FORGING TEMPERATURES FOR TYPICAL SUPERALLOYS

Alloy	Forging Temperature °C Start*	Stop**
Fe-Cr-Ni-Co	1200	980
Ni-Cr-Fe-Mo	1200	980
Ni-Mo	1200	980
Ni-Mo-Cr	1230	1010
Ni-Cr-Fe-Mo (Al-Ti)	1180	980
Co-Cr-W-Ni	1230	1010

* *Maximum.*
** *Depending on nature and degree of work.*

gradually brought up to forging temperature; or they may be charged into a furnace already at forging temperature. They should soak until they reach a uniform temperature throughout. As a general rule, they should be soaked for 1 hr. at forging temperature for each inch of thickness. A guide to forging temperatures is shown in Table VIII.

Use of a well-calibrated optical pyrometer is essential. This should be sighted on the piece to be forged when the flame is in the low-fire or off stage. A further check may be made by visually observing the hearth underneath the piece and determining whether its temperature and that of the billet are about equal.

Good practice calls for turning the stock frequently to present the cooler side to the furnace atmosphere. Once the billet reaches uniform forging temperature, nothing is gained by further soaking. Direct flame impingement on the alloys must be avoided. It is also important that fuel of low sulphur content be used.

Forging should begin immediately after withdrawal from the furnace. Even a very short time lapse may allow surface temperature to drop as much as 50°-100°C. This will shorten the time available for forging. It is also unsafe, from a forging viewpoint, to raise soaking temperatures to compensate for loss of heat during the transfer.

There are no unusual difficulties in forging these alloys. However, when starting with square ingots, care must be exercised in the initial reduction. This is usually done on flat dies. Freezing of the metal in a square ingot develops a diagonal plane of weakness. Ingots will tend to rupture along these planes if subjected to extreme pressure. Light, rapid blows are recommended until the cast structure is broken up, after which reasonably heavy blows can be used.

No attempt should be made to change the general shape of a billet during the initial stages of forging, particularly when starting with a cast ingot. The alloy should be worked down in the form of a square with equal reduction in both directions. When a square is reached with dimensions across the flats only slightly greater than those of the desired round, the rounding operation may be started.

Rounding can be done by gradually breaking the corners with light blows. This should be continued until the cross-section assumes an octagonal shape in which the four original sides are twice the width of the sides formed by breaking the corners. At this point it is advisable to change to a bottom die with a 90° V and retain the flat top die.

By placing the billet in the V with the small sides contacting the arms of the V, the hammer or press will tend to push the metal towards the centre at three points. This compresses the open centre structure and minimizes the possibility of centre bursts. This may be continued until the billet is worked into a perfect octagon whose dimensions between the flats are equal to the diameter of the finished round. Corners of the octagon are then hammered or pressed down, and the billet rounded and sized. To avoid working the metal too severely, it is advisable to use "pegs" or pieces of metal of known gauge size to meter the strokes.

Men and Metals

It has been announced by the Council of the Institute of Metals that the following awards have been made: The Platinum Medal to **Dr. Leonard Bessemer Pfeil,** O.B.E., A.R.S.M., F.I.M., F.R.S., in recognition of his outstanding contributions to non-ferrous metallurgical science and to the non-ferrous metals industries. The Rosenhain Medal to **Professor Robert William Kerr Honeycombe,** M.Sc., Ph.D., in recognition of his outstanding contributions in the field of physical metallurgy. The W. H. A. Robertson Medal and Premium to **Dr. Raymond Bernard Sims,** M.I.Mech.E., A.Inst.P., for his Paper on "Automatic Gauge Control in Rolling Mills."

Further news from the Institute of Metals is to the effect that **Dr. G. L. Bailey,** C.B.E., M.Sc., F.I.M., will take office as President of the Institute as from April 14 next, and that the following will take office on the same date as vice-presidents: **Dr. Hugh Ford,** D.Sc., Ph.D., Wh.Sc., M.I.Mech.E.; **Mr. E. H. Jones,** A.R.I.C., M.I.M.M., and **Dr. H. O'Neill,** M.Met., D.Sc., F.I.M.

To fill the vacancies on the Council of the Institute of Metals, the following have been elected: **Dr. W. O. Alexander,** B.Sc., Ph.D., F.I.M.; **Dr. N. P. Allen,** M.Met., D.Sc., F.I.M., F.R.S.; **Mr. F. Dickinson,** B.Sc., F.Inst.P., F.I.M., and **Mr. L. Rotherham,** M.Sc., F.Inst.P., F.I.M.

At a recent meeting of the Institute of Physics, the following were elected as Fellows:—**R. E. Aitchison, F. H. Aldred, J. H. Benyon, P. H. Biss, F. W. W. Colmer, J. Crangle, A. Cunliffe, J. F. Fowler, B. G. Gates, J. A. Gledhill, W. M. Jones, G. Knott, J. W. Leech, R. Roscoe, S. Sriraman, E. W. Tapper, H. E. Taylor,** and **E. G. Woodroofe.** In addition, 64 associates of the Institute were elected, 59 graduates, 115 students, and five subscribers.

The appointment of **Dr. Dudley A. Robins** as chief metallurgist at the Tin Research Institute has been announced by the International Tin Research Council. Dr. Robins succeeds **Dr. E. C. Ellwood,** who has been appointed to the chair of metallurgy at the Royal College of Science and Technology, Glasgow.

At the annual meeting of the British Bronze and Brass Ingot Manufacturers' Association, held in Birmingham last week, **Mr. James H. Barwell,** J.P.

(Allcock and Co. (Metals) Ltd.) was elected President of the Association for the ensuing year. Mr. Barwell has been a member of the Joint Standard Committee on Safety, Health and Welfare Conditions in Non-Ferrous Foundries, under the auspices of H.M. Factory Inspectorate of the Ministry of Labour and National Service.

Joining the company in 1951, **Mr. G. Patrick Eadie,** B.Sc., M.I.Mech.E., has now been appointed to the board of directors of Laidlaw, Drew and Company Limited, of Edinburgh.

Atomic Progress

—continued from page 228

At present, the greatest promise of controlling swelling seems to lie in keeping the fission gas bubbles so small that their growth is restrained by surface tension. In addition, the large effect of thermal cycling suggests that, if a fuel element is to achieve a long irradiation life, thermal cycling of the element should be minimized. However, such a recommendation brings with it far-reaching implications on reactor control and operation, and the metallurgist is urged to find a metallic uranium fuel which is resistant to swelling, and also to study the behaviour of ceramic fuels.

Reference

[1] A. T. C. Churchman, R. S. Barnes and A. M. Cottrell; *J. Nuclear Energy*, 1958, **7** (1-2), 88.

Industrial News *Home and Overseas*

Scientific Films

It is announced that the **British Association for the Advancement of Science** is to award Certificates of Participation for those films selected for screening at its annual meeting at York in September next.

The Scientific Film Committee of the Association is at present considering films recommended for screening (16 mm. only) and any sponsors, producers, distributors or users who still wish to make recommendations are asked to forward these as soon as possible to the Visual Aids Officer at the offices of the Association—18 Adam Street, Adelphi, London, W.C.2.

New Premises

At the official opening of the new premises of the **Vitreous Enamel Development Council,** at 28 Welbeck Street, London, W.1, on Wednesday of last week, Mr. Ken Jones stated that since the Council came into being some two years ago, it had succeeded in establishing minimum manufacturing standards amongst its members.

Recently, the Enamel Advisory Service was commenced in London. This is a free information service set up to deal with the many problems encountered with protective coatings and finishes on domestic and industrial products. This service has now been extended, and advisory bureaux exist in Glasgow, Cardiff, Birmingham and Manchester. This week a bureau is being opened in Newcastle, to be followed shortly by a centre in Southampton. Other centres are envisaged in the future at Norwich, Aberdeen and Belfast.

Tin Conference

Research work on the production of titanium-tin alloys by powder metallurgy methods was described to scientists at the eighth annual Paris Tin Conference, held last week.

Mr. R. F. Smart, research metallurgist at the Tin Research Institute, London, said: "The procedure developed gave very promising results, and the studies are being extended to the production of titanium-aluminium-tin alloys by this method. In general, the alloys under consideration have the advantage of maintaining excellent strength at high temperatures."

At the same conference, Dr. W. E. Hoare, assistant director of the Tin Research Institute, reviewed recent work on the use of tin to control the structure of cast iron. "The addition of quite small amounts of tin, usually less than 0·1 per cent, suppresses the ferrite phase," Dr. Hoare told his audience, and thus produces metal of better wear resistance. At the same time, the addition of tin does not promote the production of free cementite, which might adversely affect machinability. The effect of tin is very marked in hypoeutectic and in nodular irons, but somewhat less marked in the softer hypereutectic iron.

Professor Albert Portevin, President de l'Academie des Sciences, who holds the C.B.E. and is a foreign member of the Royal Society, presided over the conference and introduced the programme. Other speakers included Monsieur C. Guinard, who discussed aluminium-tin bearing alloys; Monsieur C. Chevalier, who spoke on tin base die-casting alloys, and Monsieur P. A. Jacquet, who described a new method for the metallography of tin.

A New Edition

Forty-fourth year of publication, the 1958 edition of *Quin's Metal Handbook* has just been published. This annual reference book on ores, metals, iron and steel, and scrap, comprises 600 pages and, as in previous years, every endeavour has been made to make this volume as comprehensive as possible.

It has been completely revised and brought up to date, and contains a wealth of information covering numerous countries, relating to prices, production, consumption, exports, imports, brands and stocks of non-ferrous metals, minerals, scrap, iron and steel, ferro-alloys, tinplates, etc. Concisely indexed, quick and easy reference to any metal in any part of the world is readily available. This book is obtainable, price £1 7s. 6d., from Metal Information Bureau Ltd.

A Russian Translation

A copy of "Automatic Welding" has just reached us from the **British Welding Research Association.** This is a cover-to-cover translation of the Russian journal *Avtomaticheskaya Svarka,* which is the organ of the Arc Welding Institute at Kiev. The regular monthly production of "Automatic Welding" is due to begin next month with the translation of the January issue of the Russian journal.

It is of interest to learn that the Department of Scientific and Industrial Research, which is sponsoring this effort, is also supporting 23 other cover-to-cover translations from the Russian.

Agency Appointment

It is learned from **John E. Moore Limited** that they have appointed **Diversa Metals Limited** as their agents in the South of England for the purchase of aluminium scrap.

Crucibles by "Condor"

Deliveries of crucibles to customers in Scotland are being made by **The Morgan Crucible Company Limited** through the medium of the new express freight train, the "Condor," which does the journey from London to Glasgow in 10 hours. The containers with the crucibles are collected from the company's works at Battersea during the afternoon, and delivered in Glasgow and its environs the following morning.

Germanium Rectifiers

It is often more economical to convert the new A.C. supply to direct current to operate existing D.C. machines and equipment, rather than change the motors, etc., to A.C. machines where an old D.C. supply is replaced by a modern A.C. system. Selenium rectifiers have been used for this purpose at low powers, but have not been economical for outputs much above 50 kW—mercury arc rectifiers hitherto offering the best means of converting larger powers.

The germanium rectifier is now becoming established as extending the range offered by selenium. **Westinghouse Brake and Signal Company Ltd.** have just installed a 150 kW germanium rectifier for the Eastern Electricity Board, supplying 250-0-250 V 300 amp to several machines at a large London firm. Westinghouse have many other germanium or silicon rectifiers in course of construction for this type of duty, with outputs up to 500 kW, whilst equipments rated in megawatts are being built for electrolytic processes.

A Dismantling Job

Work has commenced on the dismantling of the Central Electricity Board's old Bankside Station, London, S.E., which will finally close down at the end of this month. The contract for this dismantling is being carried out by **George Cohen Sons and Co. Ltd.,** and the plant totals many thousands of tons. It includes 18 large boilers and nine turbo-alternator sets. It is expected that this contract will yield considerable quantities of non-ferrous metal, as well as steel and cast iron scrap.

Contract Received

A part of a large order received by Wales and Edwards Electric Vehicles Ltd. has been placed with the Rectifier Division of **Westinghouse Brake and Signal Co. Ltd.** This is for vehicle battery charging equipment amounting to £15,960, involving chargers with a special tapering characteristic in order to achieve reduced charging time without resorting to the usual two-rate feature.

Price Reduction

An announcement was made last week by **Wild-Barfield Electric Furnaces Ltd.** to the effect that they had reduced the price of their patented "Carbodrop" gas carburizing fluid in the U.K. This reduction follows a fall in the cost of raw materials and will result in greater savings in operating costs by users of "Carbodrip" in drip feed gas carburizing furnaces.

Bronze and Brass Founders

Members of the **Association of Bronze and Brass Founders** in the areas concerned are advised of two meetings to be held next week. Members of the Cheshire area will meet on Monday next, March 23, in the Stephenson Room, Engineers' Club, Manchester, at 4.45 p.m.

The other meeting is for members in the Scottish area, and will be held at the St. Enoch Hotel, Glasgow, on Thursday next, March 26, at 12 noon. At both these meetings the principal subject to be discussed is the proposed revisions to B.S.1400/1948.

Trade Enquiry

It is learned from the Export Services branch of the Board of Trade that the firm of Erich M. Schulze, Berlin—Charlottenburg 9, Herbartstrasse 28, have informed the British Consulate-General at Berlin that they are interested in receiving quotations from U.K. suppliers of the following:—

Tube welding equipment, complete for welding—(a) gas and water pipes, ¼ in. to 3 in. of standard material; (b) boiler tubes, measuring 25-108 mm. and made of appropriate alloys; they are to be welded longitudinally according to the German DIN standards DIN 17175, which is equivalent to the former DIN 2448.

Both types of tubes, as well as the boiler tubes, should be processed on one and the same plant. This is achieved by running the pipes through a reduction machine of the equivalent type as is now manufactured by the German firms of Friedrich Kocks and Meer.

Interested U.K. suppliers are advised to contact the Berlin firm direct.

Gauge and Tool Makers

It has been announced by the **Gauge and Tool Makers' Association** that the next trade luncheon will be held at the Dorchester Hotel, London, on Wednesday, April 15 next, at 2.15 p.m. The guest of honour and chief speaker will be Mr. D. H. Robarts, chairman of the National Provincial Bank Ltd.

Tin Statistics

Advance statistics published by the International Tin Council show a slight increase in December mine production of tin-in-concentrates for the Federation of Malaya (2,729 tons) and the Belgian Congo (845 tons). Output in Indonesia fell to 1,215 tons.

Exports of tin-in-concentrates from Bolivia fell sharply in December to 582 tons. Exports from Nigeria (285 tons) and Thailand (305) were also substantially lower.

Imports of tin-in-concentrates into Singapore and the Federation of Malaya declined further in December to 486 tons. Imports into the United Kingdom rose to 2,757 tons in December but fell heavily in January to 1,337. Imports into the Netherlands in December amounted to 1,514 tons.

Exports of tin metal from the Federation of Malaya and Singapore totalled 3,474 tons in January. In December, exports from the United Kingdom were exceptionally heavy at 1,745 tons, but exports from the Netherlands fell to 1,682 tons.

Imports of tin metal into the United Kingdom fell to 317 tons in December. Imports into France also declined in December to 789 tons, but imports into the Netherlands rose to 951 tons. During November, imports into West Germany amounted to 741 tons, compared with 1,274 tons in October.

Following the record October figure, tinplate shipments in the United States fell to 114,044 tons in November and 148,914 tons in December. Production in the United Kingdom fell to 88,500 tons in November but recovered to 103,900 in December.

Ventilation on Show

Industrialists with any ventilation or heating problems should find much to interest them at the stand (No. C.24) of **Colt Ventilation Ltd.** at the forthcoming Factory Equipment Exhibition, which is being held at Earls Court, London, from April 7 to 17 next.

Exhibits on the stand will show the benefits of ventilation to industry. Ease of fixing, good design and appearance will be displayed in the unit ventilators and heaters comprised in the Colt system which will be built into this stand in typical industrial building constructions. These Colt ventilators, in high-grade durable aluminium, are effortlessly controlled by quality pneumatic, screw rod, electrical or cord controls, all of which may be operated by visitors to the stand.

A special feature will also be made of ventilation with fire protection. Among new equipment to be shown will be a very powerful fan-operated extractor unit, and the special flap-opening S.R. ventilator, a natural extract ventilator which in summer time can be boosted to provide the additional air changes necessary to cope with the summer problem.

For office ventilation the unique medal-winning luxury Colt two-way fan, which provides simultaneous extract and inlet ventilation, with warm and filtered air if desired, will also be demonstrated.

Pneumatic Equipment

A combined exhibition and film show is being arranged by **Benton and Stone Ltd.**, to be held next month at Park Lane House, London, W.1, when a full range of their latest designs of pneumatic cylinders and control valves and centralized lubrication equipment will be on show. Practical demonstrations will also be given.

In addition, the company will exhibit a coloured film, "Air Controlled," in which is illustrated some of the many ways in which increased productivity has been achieved in various trades by the use of pneumatic equipment. The company has recently moved into a new warehouse, with a floor space of about 20,000 ft², equipped with some of the latest ideas in stock control and handling.

India's Lead and Zinc

Output of lead and zinc ores in India during 1958 was 119,556 tons, against 95,462 tons in 1957, according to the Indian Bureau of Mines. This represents an increase of about 25 per cent over the previous year. The entire production came from the Zawar mines of Udaipur district, Rajasthan.

The recovery of lead and zinc concentrates during 1958 amounted to 5,257 tons and 7,245 tons respectively, against 4,850 tons and 7,469 tons during 1957. The lead concentrates are sent to the smelting plant at Tundoo in Bihar. Zinc concentrates go to Japan for smelting.

Belgian Aluminium Output

In its annual report, Societe Sidal, Belgium's main producer, manufactured 27,007 tons of aluminium semi-products last year, against 21,112 tons in 1957. Last year's figure represented 72·8 per cent of Belgium's total output (70·1 per cent in 1957). The report stated that on the basis of its present production and equipment, the company would be able to hold its own against any competition resulting from the formation of the Common Market.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange warehouses fell by 444 tons, and were distributed as follows at the end of last week:—London 5,511 tons, Liverpool 5,032 tons, and Hull 1,195 tons. Stocks of refined copper rose by 510 tons and were as follows:—London 2,047 tons, Liverpool 3,605 tons, Birmingham 300 tons, and Manchester 2,625 tons.

Tin Shipments

Singapore tin shipments in the first half of March totalled 64½ tons, according to the Straits Trading Company. This compared with 56½ tons in the first half of February and 445½ tons in the first half of March last year.

Of this month's shipments, the United States took 14 tons, Japan 5, Pacific 44½, and Australasia 1 ton.

Penang shipments during the same periods amounted to 1,645¼ tons, against 1,458¼ and 1,157½ tons respectively.

Of the first-half March shipments, the United States took 1,000 tons, Europe 50, Canada 55, Japan 326, India 53, South America 89¼, Australasia 63, and the Middle East 8½ tons.

A Yorkshire Meeting

Members of the **Association of Bronze and Brass Founders** in the Yorkshire area are reminded that a meeting has been arranged for Wednesday next (March 25) at the George Hotel, Huddersfield, at 12 noon. Following luncheon, a discussion has been arranged on apprentice recruitment and training.

Aluminium in Building

An interesting one-day exhibition is being held at the Engineering Centre, Birmingham, on Wednesday, April 8 next, from 11 a.m. until 2 p.m. under the title of "Aluminium in the Building Industry." This exhibition is provided by **Deutsch and Brenner Ltd.**, and a wide range of sheet, section, extrusions, pressings and fabrications covering a variety of applications will be displayed, giving some idea of the versatility of aluminium and its alloys.

Open Days

It is announced by the Department of Scientific and Industrial Research that the **Water Pollution Research Laboratory** at Stevenage will be holding its first Open Days on Wednesday and Thursday, May 6 and 7, when the work of the laboratory will be on view to those interested in the treatment of sewage and industrial waste waters, and the control of pollution of natural waters.

Applications for invitations to one or other of these days should be sent to the Director of the Laboratory at Elder Way, Stevenage, Herts.

London Metal Exchange

Readers are asked to note that after the morning session on Thursday next (March 26), the rooms of the London Metal Exchange will close for the Easter recess, and re-open on the morning of Tuesday, March 31.

Average Metal Prices

A useful wall chart has been issued by **Vivian, Younger and Bond Ltd.**, showing in colour, graphs of the average monthly prices of copper, lead, tin and zinc for the past twenty years (1939-1958). The annual highest and lowest prices for the metals are also given for the same period.

Personnel Protection Densitometer

A new instrument has been designed for the rapid and accurate measurement of density of processed protection film badges used by radiographers and persons engaged in radiography. This instrument, produced by **Baldwin Instrument Company Ltd.**, enables low levels of density to be measured with a high degree of accuracy.

The instrument comprises two units, a controlled light source and a vacuum type photoelectric cell with a D.C. amplifier.

It is portable and easy to use, which renders it suitable for semi-skilled operators.

Tin Prospects

Writing in their monthly review, A. Strauss and Company Ltd. state that the present statistical position of tin is very strong. They estimate an average shortage of at least 2,000 tons a month which will have to be filled mainly by Buffer Stock releases, and, if present conditions remain unchanged, probably at steadily improving prices. The tin scheme has now demonstrably fulfilled its purpose of maintaining prices within a range that is acceptable to both producers and consumers and preventing sharp fluctuations within that range, the review continues.

With the market price above £780 per ton and the Special Fund for tin holdings liquidated, there must be a general temptation to sell a large part of the 23,000 tons of metal in the Buffer Stock as soon as possible. It has cost a lot of money to hold over a long period in warehouse charges and interest on capital. The prospect of quickly reducing these burdens is attractive. So must be the desire to replace metal by cash as a reserve against possible contingencies, the review adds.

But there are other important considerations that counsel slow rather than rapid liquidation of the Buffer Stock, it continues. If large quantities were thrown on the market now, consumers might become over-confident through a belief that requirements could be met around £780 per ton, and resume an understocking policy. This would postpone any further increase in production quotas.

It is essential that some metal should be retained in the Buffer Stock to sell at £880, should excess demand force prices to that level at any time. A reasonable estimate of the amount that should be retained for that purpose, states the review, would be 6,000 tons—a quarter of the Buffer Stock.

Training Centre Display

Boys from the National Foundry Craft Training Centre at West Bromwich, Staffs., will be responsible for one of the most impressive and spectacular displays at the **Foundry Exhibition,** which is to be held at the Bingley Hall, Birmingham, from May 21 to 30 next. A score of students, average age 16-17, working in shifts in teams of four, will man a complete foundry in miniature and demonstrate the type of work and training carried out at the Centre.

It is understood that firms who are exhibiting are providing the equipment, and the boys will demonstrate furnace melting, using aluminium as well as iron. Their work will cover core making, moulding and casting, using various crafts and techniques. This is the first occasion on which the Centre has undertaken such a demonstration, which should do much to indicate to the foundry industry generally the value of the instruction given to the youngsters they send to the Centre.

The West Bromwich Centre has been in existence for some ten years, and at present there is a waiting list of would-be students, who come from foundry firms all over the country and who stay at their own residential club whilst they are taking the course. Courses accommodate a dozen boys at a time, each boy going to the Centre for four separate months within three years.

New Division Formed

For some years, the **Incandescent Heat Co. Ltd.** have manufactured process equipment to the designs of the Swenson Evaporator Co. (a division of the Whiting Corporation), of Harvey, Illinois. An agreement has now been reached by which Incandescent have exclusive selling and manufacturing rights in the United Kingdom for all Swenson products.

To handle this work, a Chemical Plant Division has been formed, headed by Mr. C. J. V. Denning. In addition to dealing with all enquiries for Swenson evaporators, crystallizers, filters and spray driers, the Division will also handle sales of direct-fired heaters and combustors, air heaters and other specialized high-temperature heat exchangers, high-temperature furnaces, and other thermal equipment of interest to users of chemical process plant.

Metal Cutting Techniques

Latest techniques in the use of cutting equipment in salvage work were studied by an eight-man salvage team from the Mersey Dock and Harbour Board when they attended the welding school run by **British Oxygen Gases Ltd.** at Worsley, Manchester, recently.

The men operate a 24-hr. watch from two salvage tenders stationed on the River Mersey. They are responsible for an area of 125 square miles of seaways, and it is their duty to maintain clear shipping routes. This sometimes involves the cutting of fouled anchor chains and removal of wrecks.

At the course at Worsley, the team studied safety precautions, use and handling of cutting equipment, cutting of mild steel plate up to 6 in. thick, and chain up to 2½ in. thick. They were impressed by the B.O.C. Saffire cutting blowpipe, which they used during the course, and the Board has now decided, we understand, to purchase four of these cutters.

Aluminium Production in Norway

News from Oslo is to the effect that the Mosjöen Aluminium A/S, Mosal, which started operation a year ago, is now completing the installation of 16 new furnaces which will increase production capacity from 22,000 to 25,000 tons annually.

There are further expansion plans for another 32 furnaces, which will bring the capacity up to 30,000-32,000 tons a year. It is planned that this second stage shall be finished simultaneously with the completion of the new Rossaga hydro-electric power station towards the end of 1961, Available resources of water power would make an eventual annual output of 70,000 tons possible.

Japanese Titanium

According to reports from Tokyo, the Export Council, jointly organized by the Japanese Ministry of Trade and the local titanium industry, has set Japanese production and export targets for titanium sponge for the 1959-1960 financial year starting April 1 at 2,100 tons and 1,884 tons respectively. The Titanium Industrial Association said planned output of titanium sponge for the current financial year ending March 31 amounted to 1,742 tons, while the export target stood at 1,767 tons.

The Association said the export plan of 1,884 tons will include 1,272 tons to be supplied to the Commodity Credit Corporation for the United States strategic stockpiling programme, under a long-term contract with Japanese makers extending to January, 1962. In addition, about 612 tons are likely to be required by American civil mill producers, compared with 495 tons in the current financial year, the Association added.

Domestic requirements for titanium sponge from soda, rayon, and petrochemical industries have been increasing considerably, the Association said. During the current financial year, these industries are expected to consume 102 tons of titanium sponge, while domestic consumption for the next financial year is expected to expand to 160 tons, the Association added. The Japanese titanium refineries are Osaka Titanium, Toho Titanium and Nippon Soda Companies.

Price of Mercury

On Wednesday last, price of quicksilver for immediate delivery ex warehouse was quoted at £75 per flask, compared with £74 to £75 last week. The harder tone is felt to be indicative of the lack of offers, rather than to any pick-up in demand. Most dealers, in fact, report scant interest by buyers. For the moment it seems that arrivals of Mexican metal have been smaller than expected, but it is still possible to buy metal for forward shipment at about £70 to £71 per flask c.i.f. The general opinion is that the present tendency is unlikely to foreshadow a sustained upturn. There is no shortage of supplies generally, and although Spain and Italy continue to quote £80 per flask f.o.b., stocks in Italy are spoken of as substantial. Some sections of the trade put the figure as high as 80,000 flasks, although others put the total at not more than 50,000.

Forthcoming Meetings

March 24 — Institution of Production Engineers. Manchester Section. Reynold's Hall, Manchester College of Science and Technology, Sackville Street, Manchester. Annual General Meeting (Members only) followed by: "Machining of Uranium, Thorium, Niobium, Vanadium, Zirconium, and Beryllium." A. Piggott. 6.30 p.m.

March 24—Institute of Metal Finishing. South-West Branch. The Grand Hotel, Bristol. Annual General Meeting. 6.30 p.m.

March 25—Institute of British Foundrymen. Birmingham Branch. James Watt Memorial Institute, Great Charles Street, Birmingham, 3. "Planning, Production and Progress." W. L. Beasley and H. D. Adey. 7.15 p.m.

March 25—Institute of British Foundrymen. London Branch. Constitutional Club, Northumberland Avenue, London, W.C.2. "Some Aspects of Small Foundry Practice." F. P. Robinson. 7.30 p.m.

March 26—Institution of Plant Engineers. Sheffield Branch. The Grand Hotel, Sheffield. "Refractories." T. R. Lynam. 7.30 p.m.

March 26—Institute of Metals. Sheffield Local Section. Engineering Lecture Theatre, The University, St. George's Square, Sheffield, 1. "The Nimonic Alloys." W. Betteridge. 7.30 p.m.

Metal Market News

LAST week saw considerable activity on the Metal Exchange, where turnovers were mostly above the average, tin being outstanding in this respect with a turnover of some 1,160 tons. Sentiment continues to be favourable, and the movement of many stocks and shares was upwards. Wall Street also put up a good show, and the outlook in the States appears to be, on the whole, satisfactory. So far as copper is concerned there was no change in the American price structure, which remained to a great extent nominal, for the custom smelters had withdrawn at 32 cents while the producers, at 31·50 cents, apparently had nothing to sell. Dealers were reported to be making 34 cents and there was every indication that the producers' and custom smelters' quotation would shortly be raised to higher levels. As we write, the February statistics have not yet been published by the Copper Institute, but it seems to be fairly generally anticipated that there will be a substantial increase in the volume of stocks outside the U.S.A. Inside the States, such change as occurs could well be downwards, but the chances are that there will not be much alteration, for reserves were already low at the end of January. In the copper ring last week there was a turnover of some 10,500 tons, apart from deals put through on the Kerb, and the tone was quite firm. At the close on Friday afternoon, cash was up by £6 5s. 0d. and three months by £6, the quotations being £251 15s. 0d. prompt and £251 forward.

It will be noticed that the backwardation widened during the week from 10s. to 15s., and this in spite of the fact that stocks in Metal Exchange warehouses advanced by 850 tons to 8,067 tons. No doubt the demand for the cash position was well maintained, but it may be doubted whether any shipments across the Atlantic have yet been made. That a threat of this nature exists can hardly be doubted, and if America moves higher without much further advance here, then it is pretty certain that copper will leave this country for the United States. If this happens, then we must expect to see the premium for cash get larger, but it is very much to be hoped that stocks will continue to increase, for 8,000 tons is not an adequate backing for the volume of business put through nowadays in Whittington Avenue. Early in the week, the Belgian price was raised by half a franc to 34·50 francs per kilo. One way and another the copper market had a good deal of encouragement last week, but signs are not lacking that the advance is now beginning to slow down. For one thing, business outside the market last week was poor, and it appears that in the U.K. and in Europe generally consumers are showing little interest.

That copper will go higher is by no means unlikely. Indeed, it may well be said to be probable, for American supply difficulties are not going to be solved overnight, and the London market can hardly be expected to ignore a further rise in the States. The only doubt is to what extent it may have been already discounted in the ruling quotation in Whittington Avenue. Tin was unusually active and the turnover well above the weekly average. The close at £781 for cash and £784 10s. 0d. three months showed an advance on the week of £3 10s. 0d. for both positions. L.M.E. warehouse stocks fell by a further 667 tons to 12,182 tons. The price last week was in the range for the Pool to sell. Lead was active, with a turnover of 11,150 tons. At £69 2s. 6d., March was down by £2 2s. 6d., while June lost 30s. at £71 7s. 6d. Some 7,125 tons of zinc changed hands, prompt losing 10s. to £75 15s. 0d. while June was unchanged at £74 5s. 0d.

New York

Copper futures were erratic, but latterly steadier on some covering and new buying in active dealings. Physical copper continued tight and strong. Custom smelters were still withdrawn as sellers of electrolytic, but are now bidding 27½ cents a lb, for scrap copper No. 2, ¾ cent a lb. over the last price. However, offerings of scrap copper are still tight, and this is restricting the ability of custom smelters to offer copper. Production copper was tight and showed a firm undertone. One leading copper source said that on the basis of the current London Metal Exchange price, foreign copper would have to sell around 35 cents delivered to make delivery of foreign copper to the U.S. worth while. Dealers were offering copper f.a.s. Gulf or Tacoma, Washington, at 33 cents a lb. This is foreign copper which is in bond, and if sold on export basis avoids the 1·7 cents duty.

Tin was very steady, but quiet. Lead was quiet, and zinc reported fair business.

Paris

The Pechiney report for 1958 is considered very satisfactory. Aluminium production increased from 132,000 tons in 1957 to 139,000 tons in 1958, and the three factories of Pechiney, Ugine and Alucam delivered 195,000 tons last year, against 171,000 tons in 1957. Exports showed an increase from 21,600 tons in 1957 to 56,100 tons last year. The company hopes to do even better this year. By 1960 the new plant at Nogueres, near Lacq, will come into production with an annual output of about 56,000 tons per year. The cost of the plant is estimated at around £23,000,000. Finally, the report says that by the end of 1960 the company will have made up all that was lost during the war years and the years immediately following the war.

The Common Market is no threat, and competition will be met without any difficulty. A further report states that Pechiney will organize and administer the mining of bauxite in what was French Guinea with American, French, British, Swiss and German capital.

Aluminium prices were increased by 6·2 per cent last month. The increase is due to higher transport costs in France, dearer electricity, and imported raw materials and fuel. It is pointed out that salary increases are not included in advanced prices. These increases were carried by increased production.

France will produce no more than 40 kilos of plutonium in 1959. The target was 100 kilos. There are several reasons for the difference. Most of them are said to be due to faulty organization and incidents. It is pointed out, however, that 40 kilos is enough to permit France to try two bombs.

Birmingham

Conditions in the non-ferrous metal-using industries in the Midland area have changed little since the beginning of the year. Consumption is moderate and many users hesitate to stock more material than they need for immediate orders. Builders' ironmongery and brassfoundry is being taken up somewhat more readily, due to slight expansion in the building trade. There is also more buying in hand tools, but makers of machine tools are still working below capacity. Export trade is not losing ground, but manufacturers are finding it increasingly difficult to compete against the low prices quoted by some Continental makers.

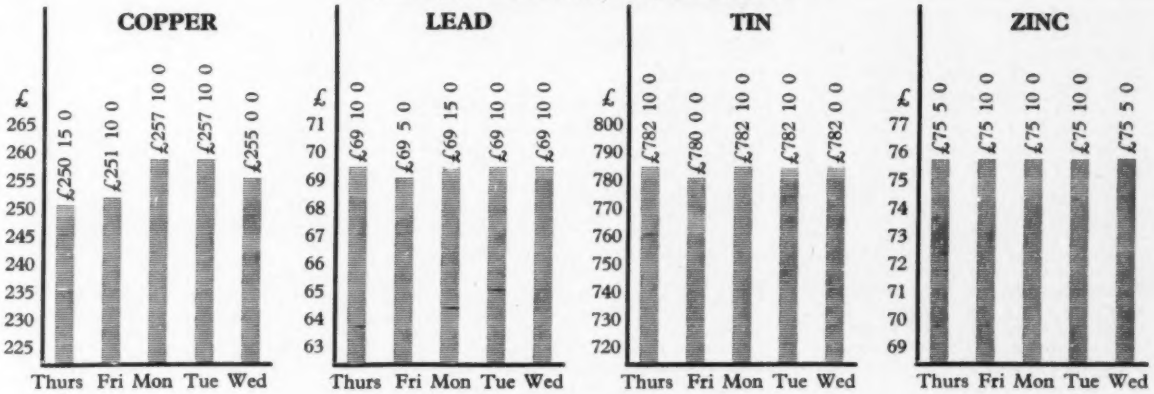
In his report to the annual meeting of the National and Midland Ironfounders' Association, held recently in Birmingham, the chairman commented that the recession which British industry had experienced fell with double emphasis on ironfounders, and particularly those not serving the automobile industry. One would expect a large group with its own ironfoundry responsible for part of its castings requirements, to curtail orders to outside suppliers. The result had been that, in many cases, the effects of the recession had fallen more harshly on the jobbing ironfounder than on other sections of the trade.

Recent figures of output in the steel trade show figures about 18 per cent lower than a year ago. Present capacity in rolling works far exceeds current demand, except in the cases of heavy plates. Substantial tonnages of sheets are being delivered to the car manufacturers.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 12 March to Wednesday 18 March 1959



Primary Metals

All prices quoted are those available at 2 p.m. 18/3/59

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		9	0
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		14	0
Columbite	per unit		—	
Copper H.C. Electro	ton	255	0	0
Fire Refined 99·70%	„	254	0	0
Fire Refined 99·50%	„	253	0	0

		£	s.	d.
Copper Sulphate	ton	78	0	0
Germanium	grm.		—	
Gold	oz.	12	9	2
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	69	10	0
Magnesium Ingots	lb.		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		6	1
Alloy Ingot, A8 or AZ91	„		2	4
Manganese Metal	ton	245	0	0
Mercury	flask	75	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	

		£	s.	d.
Palladium	oz.	5	15	0
Platinum	„	28	10	0
Rhodium	„	40	0	0
Ruthenium	„	14	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	7⅜
Tellurium	lb.		15	0
Tin	ton	782	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	74	13	9
Dust 95/97%	„	109	0	0
Dust 98/99%	„	115	0	0
Granulated 99+%	„	99	13	9
Granulated 99·99+%	„	113	3	9

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton		**Canada** c/lb ≏ £/ton		**France** fr/kg ≏ £/ton		**Italy** lire/kg ≏ £/ton		**Switzerland** fr/kg ≏ £/ton		**United States** c/lb ≏ £/ton	
Aluminium			22.50	185 17 6	210	157 10	375	221 5	2.50	212 10	26.80	214 10
Antimony 99.0					220	165 0	445	262 10			29.00	232 0
Cadmium					1,350	1,012 10					145.00	1,160 0
Copper												
Crude							485	286 0				
Wire bars 99.9												
Electrolytic	34.50	252 0	30.50	252 0	345	258 15			2.95	250 15	31.50	252 0
Lead			10.50	86 15	103	77 5	168	99 2 6	.87	74 0	11.50	92 0
Magnesium												
Nickel			70.00	578 5	900	675 0	1,200	708 0	7.50	637 10	74.00	592 0
Tin	113.00	831 12 6			1,108	831 0	1,520	896 17 6	9.40	799 0	103.25	826 0
Zinc												
Prime western			11.25	93 0 0							11.00	88 0
High grade 99.95			11.85	97 17 6								
High grade 99.99			12.25	101 2 6								
Thermic					111.00	83 5						
Electrolytic					119.00	89 5	172	101 10	.93	79 0	12.25	98 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 18/3/59

		£	s.	d.
Aluminium Alloy (Virgin)				
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10	„	221	0	0
B.S. 1490 L.M.11	„	215	0	0
B.S. 1490 L.M.12	„	223	0	0
B.S. 1490 L.M.13	„	216	0	0
B.S. 1490 L.M.14	„	224	0	0
B.S. 1490 L.M.15	„	210	0	0
B.S. 1490 L.M.16	„	206	0	0
B.S. 1490 L.M.18	„	203	0	0
B.S. 1490 L.M.22	„	210	0	0
†Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	—		
B.S. 1490 L.M.2	„	—		
B.S. 1490 L.M.4	„	—		
B.S. 1490 L.M.6	„	—		
***Aluminium Bronze**				
BSS 1400 AB.1	ton	246	0	0
BSS 1400 AB.2	„	254	0	0

		£	s.	d.
***Brass**				
BSS 1400-B3 65/35	ton	164	0	0
BSS 249	„		—	
BSS 1400-B6 85/15	„	210	0	0
***Gunmetal**				
R.C.H. 3/4% ton	„		—	
(85/5/5/5)	„	205	0	0
(86/7/5/2)	„	211	0	0
(88/10/2/1)	„	260	0	0
(88/10/2/½)	„	272	0	0
***Manganese Bronze**				
BSS 1400 HTB1	„	205	0	0
BSS 1400 HTB2	„		—	
BSS 1400 HTB3	„	230	0	0
Nickel Silver				
Casting Quality 12%	„	230	0	0
„ „ 16%	„	240	0	0
„ „ 18%	„	255	0	0
***Phosphor Bronze**				
B.S. 1400 P.B.1.(A.I.D. released)	„	302	0	0
B.S. 1400 L.P.B.1	„	222	0	0

**Average prices for the last week-end.*

		£	s.	d.
Phosphor Copper				
10%	ton	263	0	0
15%	„	265	0	0
Phosphor Tin				
5%	„		—	
Silicon Bronze				
BSS 1400-SB1	„	270	0	0
Solder, soft, BSS 219				
Grade C Tinmans	„	364	6	0
Grade D Plumbers	„	292	9	0
Grade M	„	400	0	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	106	8	9
Mazak V	„	110	8	9
Kayem	„	116	8	9
Kayem II	„	122	8	9
Sodium-Zinc	lb.		2	6½

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

			£	s.	d.
Aluminium					
Sheet 10 S.W.G.	lb.		2	8½	
Sheet 18 S.W.G.	„		2	10½	
Sheet 24 S.W.G.	„		3	1½	
Strip 10 S.W.G.	„		2	8½	
Strip 18 S.W.G.	„		2	9½	
Strip 24 S.W.G.	„		2	11	
Circles 22 S.W.G.	„		3	2½	
Circles 18 S.W.G.	„		3	1½	
Circles 12 S.W.G.	„		3	0½	
Plate as rolled	„		2	8	
Sections	„		3	2	
Wire 10 S.W.G.	„		2	11½	
Tubes 1 in. o.d. 16 S.W.G.	„		4	1	
Aluminium Alloys					
BS1470. HS10W.					
Sheet 10 S.W.G.	„		3	1	
Sheet 18 S.W.G.	„		3	3½	
Sheet 24 S.W.G.	„		3	11	
Strip 10 S.W.G.	„		3	1	
Strip 18 S.W.G.	„		3	2½	
Strip 24 S.W.G.	„		3	10½	
BS1477. HP30M.					
Plate as rolled	„		2	11	
BS1470. HC15WP.					
Sheet 10 S.W.G.	„		3	9½	
Sheet 18 S.W.G.	„		4	2	
Sheet 24 S.W.G.	„		5	0½	
Strip 10 S.W.G.	„		3	10½	
Strip 18 S.W.G.	„		4	2	
Strip 24 S.W.G.	„		4	9½	
BS1477. HPC15WP.					
Plate heat treated	„		3	6½	
BS1475. HG10W.					
Wire 10 S.W.G.	„		3	10½	
BS1471. HT10WP.					
Tubes 1 in. o.d. 16 S.W.G.	„		5	0½	
BS1476. HE10WP.					
Sections	„		3	1½	
Brass					
Tubes	„		1	11½	
Brazed Tubes	„		—		
Drawn Strip Sections	„		—		
Sheet	ton		—		
Strip	„	263	10	0	
Extruded Bar	lb.		2	1½	
Extruded Bar (Pure Metal Basis)	„		—		

		£	s.	d.
Brass				
Condenser Plate (Yellow Metal)	ton	198	0	0
Condenser Plate (Naval Brass)	„	211	0	0
Wire	lb.		2	9½
Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Copper				
Tubes	lb.		2	5½
Sheet	ton	286	10	0
Strip	„	286	10	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	302	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	8

		£	s.	d.
Lead				
Pipes (London)	ton	112	5	0
Sheet (London)	„	110	0	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Sheet and Strip 7%	lb.		3	8½
Wire 10%	„		4	3½
Phosphor Bronze				
Wire	„		4	3½
Titanium (1,000 lb. lots)				
Billet over 4″ dia.-18″ dia.	lb.	63/-		64/-
Rod 4″ dia.-·250″ dia.	„	75/-		112/-
Wire under ·250″ dia.-·036″ dia.	„	146/-		222/-
Sheet 8′ × 2′ × ·250″-·010″		88/-		157/-
Strip ·048″-·003″	„	100/-		350/-
Tube	„			300/-
Extrusions	„			120/-
Zinc				
Sheet	ton	111	0	0
Strip	„	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 17/3/59.

	£
Aluminium	
New Cuttings	145
Old Rolled	125
Segregated Turnings	96
Brass	
Cuttings	171
Rod Ends	154
Heavy Yellow	133
Light	128
Rolled	161
Collected Scrap	131
Turnings	147
Copper	
Wire	228
Firebox, cut up	223
Heavy	220
Light	215
Cuttings	228
Turnings	208
Braziery	178

	£
Gunmetal	
Gear Wheels	200
Admiralty	200
Commercial	175
Turnings	170
Lead	
Scrap	61
Nickel	
Cuttings	—
Anodes	550
Phosphor Bronze	
Scrap	175
Turnings	170
Zinc	
Remelted	57
Cuttings	53
Old Zinc	37

Financial News

Charles Clifford Ltd.

Final dividend 7 per cent, making 10 per cent for 1958 (same). Group net profit £76,166 (£51,121), after U.K. tax £86,822 (£72,503). To general reserve £20,000 (£64,353), stock reserve £22,500 (£45,000 withdrawn).

Expanded Metal Co.

Group net profit, 1958, £122,713 (£100,411) and dividend equivalent to 16⅛ per cent (14⅜) on capital increased by scrip issue. Net current assets £753,075 (£699,783). Net assets £1,183,184 (£1,102,418) after deducting £136,827 (£119,000) future tax.

Thermal Syndicate

Accounts show net profits at £102,195 (against previous £99,825). Ordinary dividend recommended of 25 per cent (same).

Follsain-Wycliffe Foundries

Group net profit 1958 £26,666 (£33,075), after tax of £20,375 (£26,800). To general revenue reserve £5,000 (£20,000), and capital reserve £8,447 (£11,289). Final dividend 7½ per cent, making 12½ per cent on capital increased by two-for-five scrip issue (17½ per cent on old). Forward £25,825 (£23,075).

International Nickel

Net earnings of the International Nickel Company of Canada for the year ended December 31 last fell to 39,665,000 U.S. dollars, equal to 2·71 dollars per common share, from 86,141,000 U.S. dollars, or 5·90 dollars per share, in 1957, the company's annual report discloses. The drop in earnings reflected the lower demand for nickel, sharply reduced prices and deliveries of platinum metals, lower prices for copper, and a strike against the company which stopped all production at the mines and plants in Ontario during the final three months of the year.

Net earnings for the fourth quarter of 1958 were only 9,344,000 U.S. dollars, or 64 cents per share, compared with 20,124,000 dollars, or 1·38 dollars per share a year before. However, the company's chairman and President said that by mid-February, 1959, there were definite indications of an upturn in nickel demand, and the outlook for increased sales was more encouraging than at any time since the reversal of the supply-demand situation at the end of 1957.

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Wardell Wirecraft Limited (621502), 42 Devonshire Street, W.1. Registered February 20, 1959. To carry on business of manufacturers of fine wires, wire weavers, drawers and workers generally, etc. Nominal capital, £100 in £1 shares. Directors: Maj. William H. O'Dell and Louis H. J. Ward.

A. R. Knowlson and Co. Limited (621646), Howard Works, Broad Street, Sheffield. Registered February 24, 1959. To take over business of electro platers carried on as "A. R. Knowlson and Co." at 26 Eyre Lane, Sheffield, etc. Nominal capital, £2,000 in £1 shares. Permanent directors: Albert R. Knowlson and Mrs. E. Knowlson.

Fayrer Conrad Limited (621688), 308 Ewell Road, Tolworth, Surbiton, Surrey. Registered February 24, 1959. To carry on business of agents for metal merchants and dealers, etc. Nominal capital, £100 in £1 shares. Directors: Mrs. Joan C. Wells and Mrs. Jacqueline F. Brett-Holt.

E. Thorn and Sons Limited (621943), 63 Mott Street, Hockley, Birmingham. Registered February 27, 1959. To acquire part of the business of metal finishers carried on by E. Thorn and Sons Ltd. (incorporated in 1934). Nominal capital, £10,000 in £1 shares. Directors: Thos. E. Thorley, Richard Carless and Dorothy A. Carless.

Styx Products Limited (621995), Millfield, Stoke D'Abernon Cobham. Registered February 27, 1959. To carry on business of light engineers, metal stampers and piercers, etc. Nominal capital, £5,000 in £1 shares. Directors: Arthur R. B. Owen and John R. Scholfield.

Francilly Development Co. Limited (622021), 21 Red Lion Street, W.C.1. Registered February 27, 1959. To carry on business of merchants of and dealers in produce, goods, merchandise, metals, etc. Nominal capital, £100 in £1 shares. Director: Jack House.

M. J. Bailey (Cheltenham) Limited (622102), Forge Works, Andover Road, Cheltenham. Registered March 2, 1959. To carry on business of machinery and metal merchants, marine store dealers, etc. Nominal capital, £1,000 in £1 shares. Directors: Maurice J. Bailey and Nancy R. Bailey.

Smith Brothers (Rochdale) Limited (622113), Moss Street Works, Rochdale. Registered March 2, 1959. To take over business of iron and steel metal merchants carried on at Rochdale by J. W., E., A. and E. A. Smith, etc. Nominal capital, £9,000 in £1 shares. Permanent directors: James W. Smith, Ernest Smith, Amos Smith and Edwin A. Smith.

Light Metal Statistics

Figures showing the U.K. production, etc., of light metals for Dec., 1958, have been issued by the Ministry of Supply as follow (in long tons):—

Virgin Aluminium	
Production	2,474
Imports	18,037
Despatches to consumers	25,820
Secondary Aluminium	
Production	10,143
Virgin content of above	858
Despatches (including virgin content)	9,875
Secondary in Consumption (per cent)	
Wrought products	5·8
Cast products	82·9
Destructive uses (aluminium content irrecoverable)	51·3
Total consumption	26·6
Scrap	
Arisings	13,271
Estimated quantity of metal recoverable	9,212
Consumption by:	
(a) Secondary smelters	12,413
(b) Other uses	1,288
Despatches of wrought and cast products	
Sheet, strip and circles	12,823
Extrusions (excluding forging bar, wire-drawing rod and tube shell):	
(a) Bars and sections	2,833
(b) Tubes (i) extruded	191
(ii) cold drawn	715
(c) (i) Wire	1,800
(ii) Hot rolled rod (not included in (c) (i)	12
Forgings	293
Castings: (a) Sand	1,450
(b) Gravity die	3,753
(c) Pressure die	1,608
Foil	1,983
Paste	303
Magnesium Fabrication	
Sheet and strip	6
Extrusions	98
Castings	141
Forgings	2

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£205.17.6)	235
Heavy copper	(£205.17.6)	235
Light copper	(£170.17.6)	195
Heavy brass	(£113.17.6)	130
Light brass	(£92.0.0)	105
Soft lead scrap	(£57.0.0)	65
Zinc scrap	(£39.10.0)	45
Used aluminium unsorted	(£78.16.0)	90
France (francs per kilo):		
Electrolytic copper scrap	(£195.0.0)	260
Heavy copper	(£195.0.0)	260
No. 1 copper wire	(£183.15.0)	245
Light brass	(£116.5.0)	155
Zinc castings	(£48.15.0)	65
Lead	(£67.10.0)	90
Aluminium	(£112.10.0)	150
Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£197.12.6)	335
Aluminium copper alloy	(£126.17.6)	215
Lead, soft, first quality	(£79.0.0)	134
Lead, battery plates	(£43.12.6)	74
Copper, first grade	(£227.2.6)	385
Copper, second grade	(£215.7.6)	365
Bronze, first quality machinery	(£209.10.0)	355
Bronze, commercial gunmetal	(£180.0.0)	305
Brass, heavy	(£144.10.0)	245
Brass, light	(£129.17.6)	220
Brass, bar turnings	(£132.15.0)	225
New zinc sheet clippings	(£57.5.0)	97
Old zinc	(£42.10.0)	72

THE STOCK EXCHANGE

Industrials Generally Well Maintained. Delta Metal In Good Demand

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 17 MARCH	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1959 HIGH	1959 LOW	1958 HIGH	1958 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	24/4½	+4½d.	9	10	7 10 0	24/10½	23/3	24/9	17/6
400,000	2/–	Anti-Attrition Metal	1/6		4	8½	5 6 9	—	—	1/9	1/3
41,305,038	Stk. (£1)	Associated Electrical Industries ...	55/–xd		15	15	5 7 9	59/–	54/–	58/9	46/6
1,609,032	1	Birfield	49/–	—2/6	15	15	6 2 6	59/–	49/–	62/4½	46/3
3,196,667	1	Birmid Industries	73/3	—6d.	17½	17½	4 15 9	76/10½	72/–	77/6	55/3
5,630,344	Stk. (£1)	Birmingham Small Arms	37/–	+3d.	11	10	5 19 0	40/4½	36/1½	39/–	23/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	16/3		5	5	6 3 0	16/3	15/–	16/1½	14/7½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/9		6	6	6 15 3	18/1½	17/9	17/4½	16/6
500,000	1	Bolton (Thos.) & Sons	28/–	+6d.	10	12½	7 2 9	28/3	27/6	28/9	24/–
300,000	1	Ditto Pref. 5%	15/6	+6d.	5	5	6 9 0	15/6	15/–	16/–	15/–
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/6		7	7	6 16 6	—	—	20/4½	19/–
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	19/6		6	6	6 3 0	19/7½	18/9	20/–	18/4½
15,000,000	Stk. (£1)	British Insulated Callender's Cables	48/9	+1/3	12½	12½	5 2 6	53/–	47/6	52/6	38/9
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	56/–	+2/6	10	10	3 11 6	56/–	49/3	52/–	28/3
600,000	Stk. (5/–)	Canning (W.) & Co.	25/4½	+3d.	25 + *2½C	25	4 18 6	25/6	24/9	25/3	19/3
60,484	1/–	Carr (Chas.)	1/4½		12½	25	9 1 9	1/4½	1/3	2/3	1/4½
150,000	2/–	Case (Alfred) & Co. Ltd.	5/–	—1½d.	25	25	10 0 0	5/3	4/7½	5/3	4/–
555,000	1	Clifford (Chas.) Ltd.	22/10½	+1½d.	10	10	8 15 0	22/10½	22/6	22/–	16/–
45,000	1	Ditto Cum. Pref. 6%	15/3		6	6	7 17 6	—	—	16/–	15/–
250,000	2/–	Coley Metals	3/–		20	25	13 6 9	3/3	2/10½	4/6	2/6
8,730,596	1	Cons. Zinc Corp.†	61/–	—3/–	18¾	22½	6 3 9	67/6	60/6	65/3	41/–
1,509,528	1	Davy & United	93/–	—3/–	20	15	4 6 0	96/–	86/–	87/–	45/9
2,915,000	5/–	Delta Metal	28/–	+2/9	30	*17½	5 7 3	23/–	24/1½	25/–	17/7½
4,600,000	Stk. (£1)	Enfield Rolling Mills Ltd.	47/–	+2/9	12½	15B	5 6 6	47/–	36/7½	38/–	22/9
750,000	1	Evered & Co.	30/9xd	—3d.	10 §	15 Z	6 10 0	31/3	30/–	30/–	26/–
18,000,000	Stk. (£1)	General Electric Co.	31/–	—3d.	10P	12½		40/3	30/9	40/6	29/6
1,500,000	Stk. (10/–)	General Refractories Ltd	35/6	—1/–	20	20	5 12 9	40/–	35/6	39/3	27/3
401,240	1	Gibbons (Dudley) Ltd.	64/–		15	15	4 13 6	66/6	64/–	67/6	61/–
750,000	5/–	Glacier Metal Co. Ltd.	6/9		11½	11½	8 10 3	7/1½	6/7½	8/3	5/–
1,750,000	5/–	Glynwed Tubes	17/3	—3d.	20	20	5 16 0	19/3	16/4½	18/1½	12/10½
5,421,049	10/–	Goodlass Wall & Lead Industries ...	31/–	—6d.	13‖	18Z	4 4 0	31/6	28/7½	30/9	17/3
342,195	1	Greenwood & Batley	81/–	+1/6	20	17½	4 18 9	83/9	75/–	57/9	45/–
396,000	5/–	Harrison (B'ham) Ord.	15/–		*15	*15	5 0 0	15/3	14/11½	15/9	11/6
150,000	1	Ditto Cum. Pref. 7%	19/6		7	7	7 3 6	—	—	19/9	18/4½
1,075,167	5/–	Heenan Group	8/–	+3d.	10	10‡	6 5 0	8/3	7/6	9/7½	6/9
236,958,260	Stk. (£1)	Imperial Chemical Industries ...	34/10½		12Z	10	4 11 9	38/3	33/9	38/–	24/3
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	16/6	—3d.	5	5	6 1 3	16/10½	16/–	17/1½	16/–
14,584,025	**	International Nickel	170½		$2.60	$3.75	2 14 6	171	153	169	132¾
860,000	5/–	Jenks (E. P.), Ltd.	9/3		14	27½φ	7 11 3	10/–	8/9	10/–	6/7½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3		5	5	6 3 0	16/3	15/4½	16/9	15/–
3,987,435	1	Ditto Ord.	49/6	—1/9	10	10	4 0 9	52/6	44/3	47/–	36/6
600,000	10/–	Keith, Blackman	27/6		17½E	15	6 7 3	27/6	25/–	28/9	15/–
320,000	4/–	London Aluminium	5/10½	+7½d.	10	10	6 16 3	6/–	5/3	6/–	3/–
765,012	1	McKechnie Brothers Ord.	42/6	—9d.	15	15	7 1 3	45/–	42/6	45/–	32/–
1,530,024	1	Ditto A Ord.	40/–	—1/3	15	15	7 10 0	43/6	40/–	45/–	30/–
1,109,269	5/–	Manganese Bronze & Brass	15/6	+1/3	20	27½‡	6 9 0	15/6	13/9	14/1½	8/9
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–		7½	7½	7 10 0	—	—	6/3	5/6
13,099,855	Stk. (£1)	Metal Box	77/6	+2/6	11	11	2 18 9	77/6	66/6	73/3	40/6
415,760	Stk. (2/–)	Metal Traders	9/–		50	50	11 2 3	9/1½	1/6	9/–	6/3
160,000	1	Mint (The) Birmingham	22/9	+3d.	10	10	8 15 9	22/9	22/–	22/9	19/–
80,000	5	Ditto Pref. 6%	72/6	+2/–	6	6	8 5 6	75/6	69/–	83/6	69/–
3,705,670	Stk. (£1)	Morgan Crucible A	44/6	+6d.	10	10	4 10 0	45/9	43/6	45/–	34/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6	—3d.	5½	5½	6 5 9	18/6	17/6	18/–	17/–
2,200,000	Stk. (£1)	Murex	49/–	—6d.	17½	20	7 2 9	49/6	42/–	58/9	46/–
468,000	5/–	Ratcliffs (Great Bridge)	10/4½		10	10	4 16 6	11/3	10/4½	11/1½	6/10½
234,960	10/–	Sanderson Bros. & Newbould ...	28/9	+6d.	20	27½D	6 19 3	28/9	27/9	27/3	24/6
1,365,000	Stk. (5/–)	Serck	18/3	+1½d.	15	17½	4 2 3	19/–	18/–	18/7½	11/–
6,698,586	Stk. (£1)	Stone-Platt Industries	44/6		15	12½	6 14 9	46/9	43/3	45/6	22/6
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	16/1½		5½	5½	6 16 6	16/7½	15/10½	16/3	12/7½
18,255,218	Stk. (£1)	Tube Investments Ord.	80/–	—1½d.	17½	15	4 7 6	83/3	72/–	86/–	48/4½
41,000,000	Stk. (£1)	Vickers	31/9	+6d.	10	10	6 6 0	37/–	30/6	36/3	28/9
750,000	Stk. (£1)	Ditto Pref. 5%	14/9		5	5	6 15 6	15/0¾	14/7½	15/9	14/3
6,963,807	Stk. (£1)	Ditto Pref. 5% tax free	21/6		•5	•5	7 3 6A	22/7½	21/7½	23/–	21/3
2,200,000	1	Ward (Thos. W.), Ord.	83/9xd	+10½d.	20	15	4 15 6	87/6	83/6	87/3	70/9
2,666,034	Stk. (£1)	Westinghouse Brake	43/3	—3d.	10	10	4 12 6	47/–	39/9	46/6	32/6
225,000	2/–	Wolverhampton Die-Casting ...	9/–		30	25	6 13 3	9/–	8/8½	10/1½	7/–
591,000	5/–	Wolverhampton Metal	22/9	—3d.	27½	27½	6 0 9	23/–	21/6	22/9	14/9
78,465	2/6	Wright, Bindley & Gell	6/1½	—1½d.	20	20	8 3 3	6/6	4/11½	5/4½	2/9
124,140	1	Ditto Cum. Pref. 6%	13/6		6	6	8 17 9	—	—	13/–	11/3
150,000	1/–	Zinc Alloy Rust Proof	3/–		27	40D	9 0 0	3/–	2/9	3/1½	2/7½

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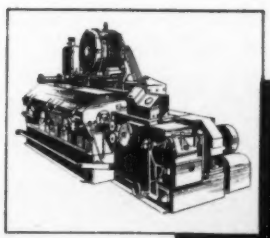

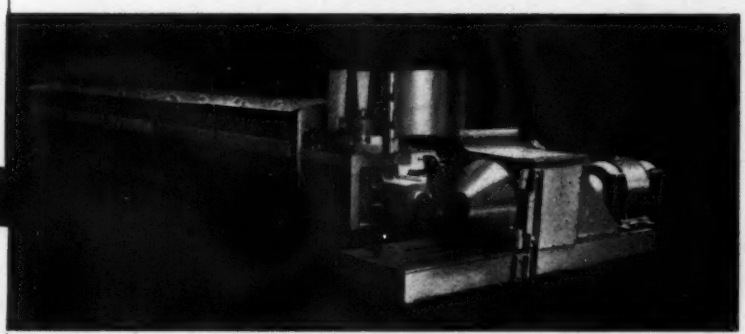

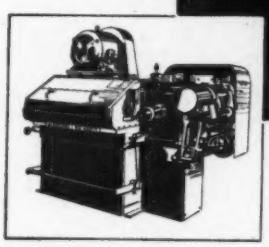

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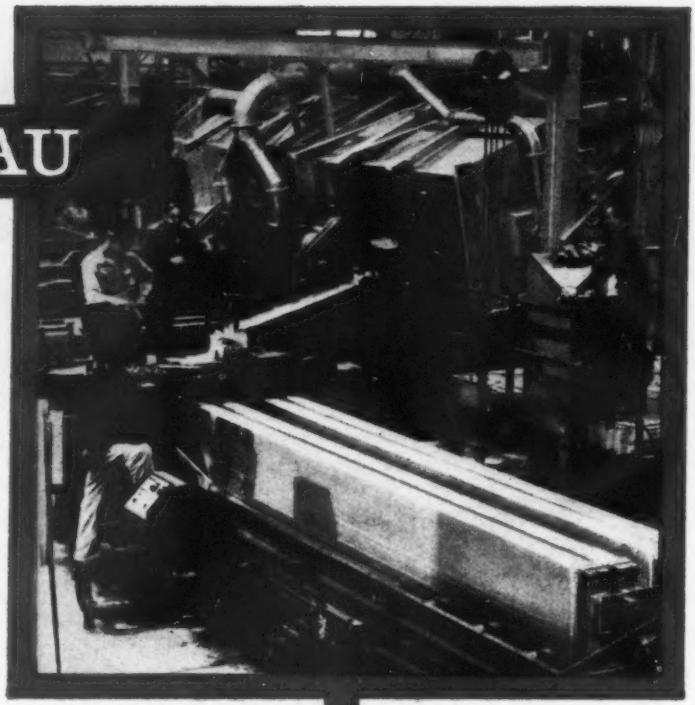

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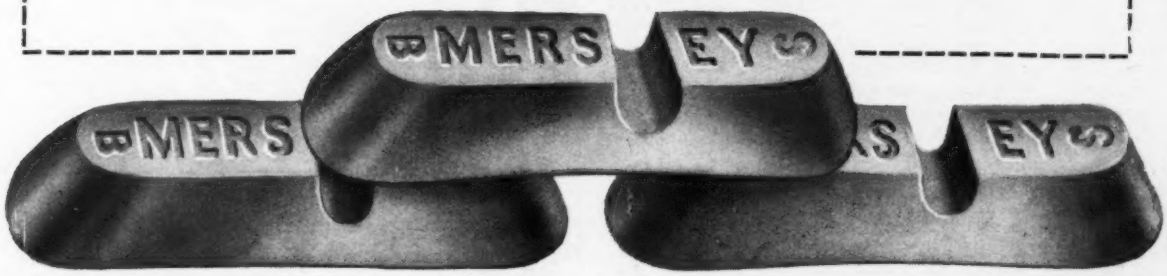

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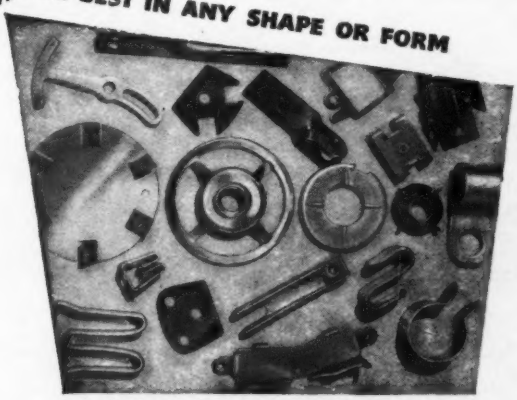

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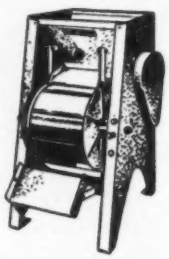

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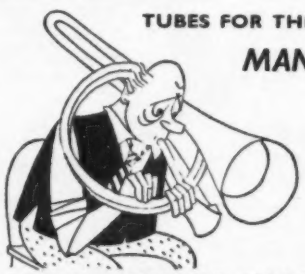

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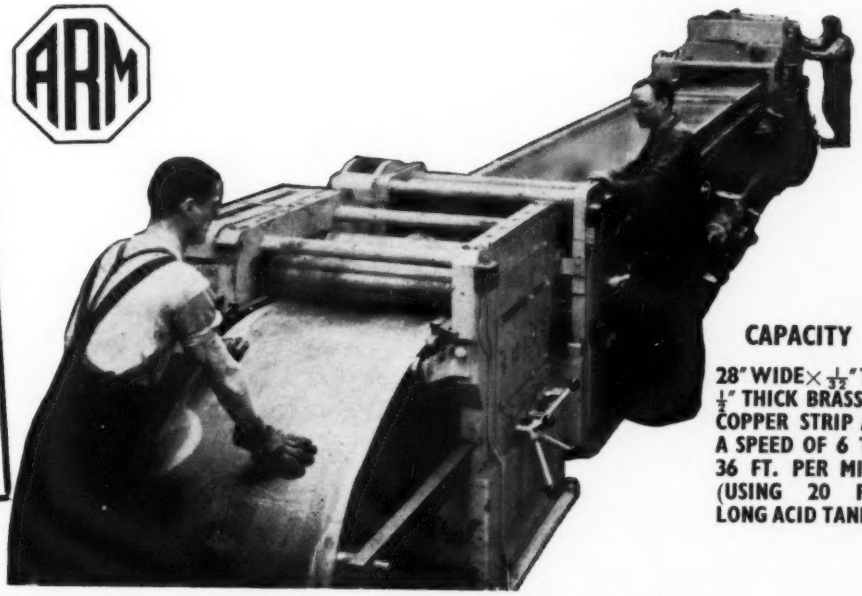

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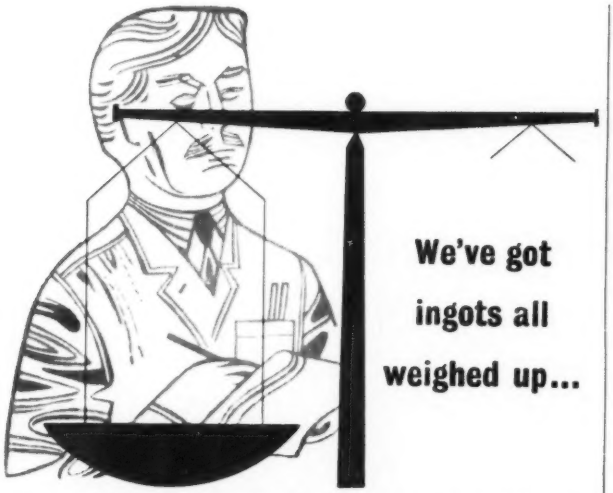

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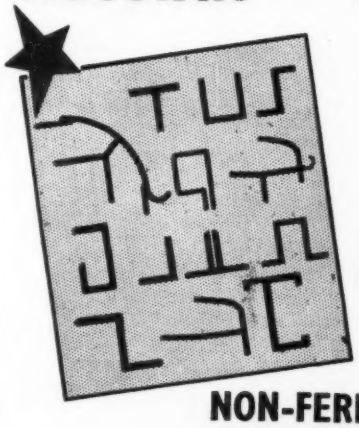

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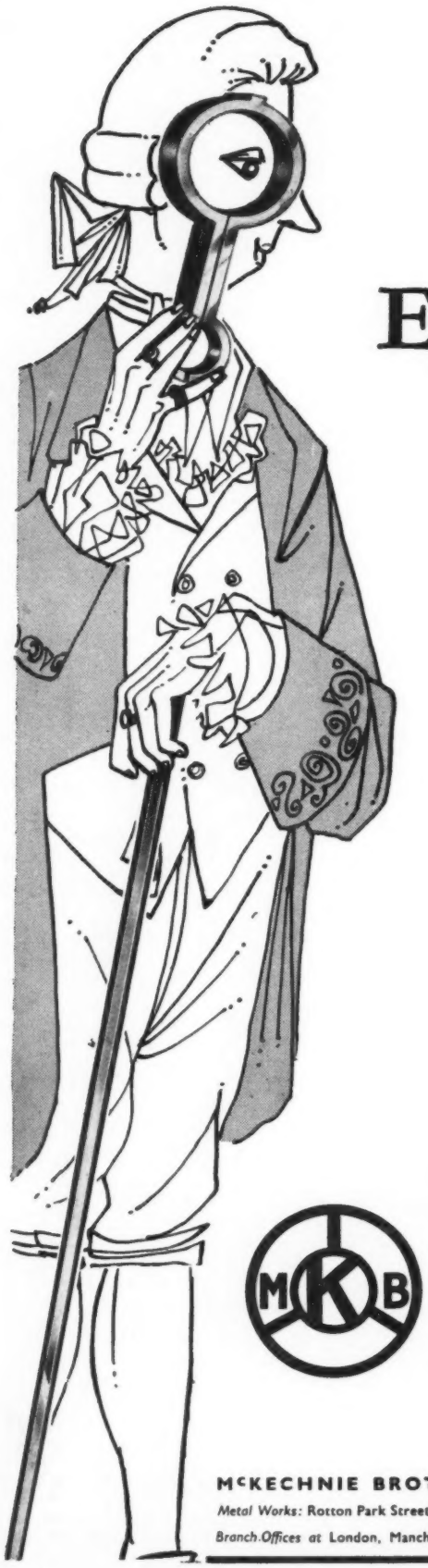

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